ECOLOGICAL IMPACTS OF THE PROPOSED RECONSTRUCTION OF KY 92 IN McCREARY AND WHITLEY COUNTIES, KENTUCKY

A Thesis
Presented to
The Faculty of the College of Science and Technology
Morehead State University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

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by
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Accepted by the faculty of the College of Science and Technology, Morehead State University, in partial fulfillment of the requirements for the Master of Science degree.

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4-29-98
Date

ABSTRACT

ECOLOGICAL IMPACTS OF THE PROPOSED RECONSTRUCTION OF HIGHWAY KY 92 IN McCREARY AND WHITLEY COUNTIES, KENTUCKY

Peggy C. Measel
1998

Director of Thesis Jerry F. Howell, Jr.

The purpose of the study is to identify terrestrial and aquatic ecological impacts associated with the reconstruction of KY 92 in the Eastern Kentucky Coal Field in McCreary and Whitley Counties, Kentucky. Environmental studies involving terrestrial zoology and botany, and aquatic studies involving stream water chemistry, aquatic macroinvertebrates, and fishes were conducted along six alternate alignments. Wetlands were identified and delineated according to the Army Corps of Engineers guidelines. Studies determined that several rare species, both animal and plant, inhabited the area and may be impacted with the project's construction. Streams will be altered by culverts, bridges and rechanneling. Brier Creek, in particular will be completely changed. A record of the federally endangered Cumberland blackside dace exists at the mouth of Brier Creek. Large mammals such as the whitetail deer, bear, and possibly cougar will have travel corridors disrupted.

and possibly cougar will have travel corridors disrupted. Forested areas will be fragmented, a condition especially hazardous to neotropical migratory birds. Mitigation measures to avoid or lessen the project impacts were discussed.

Accepted by: Jerry F. Howell, Jr.

Acknowledgements

I greatly appreciate the field assistance of Mr. Brian Binion, Ms. Brenda Hamm, and Dr. Les Meade. I appreciate the reviews and advice of my Committee members, Dr. Les Meade, Mr. Fred Busroe, and especially Dr. Jerry Howell, who used all available red ink to correct numerous copies of this report. I am grateful to Dr. Gerald DeMoss who identified those macroinvertebrates I collected. Ms. Linda Perry, US Forest Service biologist at the Stearns Ranger District of the Daniel Boone National Forest, was helpful in supplying maps and pointing out documented sightings of endangered species near the project impact area. Doug Stephens, Tim Slone, and Derk Bradley of Kentucky Department of Fish and Wildlife Resources donated their time to assist me in fisheries sampling of some area streams. Their donation of equipment, time and skill is greatly appreciated. My mother was a constant encouragement to me as I attempted to juggle this Thesis, my work, and my Life. I thank my son, Russell, who accompanied me on some of my field excursions, for his undying curiosity, enthusiasm, and love for the Great Earth. I also wish to express my gratitude to my employer, Clyde Brown of T.H.E. Engineers, Inc., for providing equipment and approval to complete this study. I especially thank Jeff Baker of T.H.E. for his time and skill in producing the maps used in this report, and Craig Morgan for his invaluable assistance with formatting the document.

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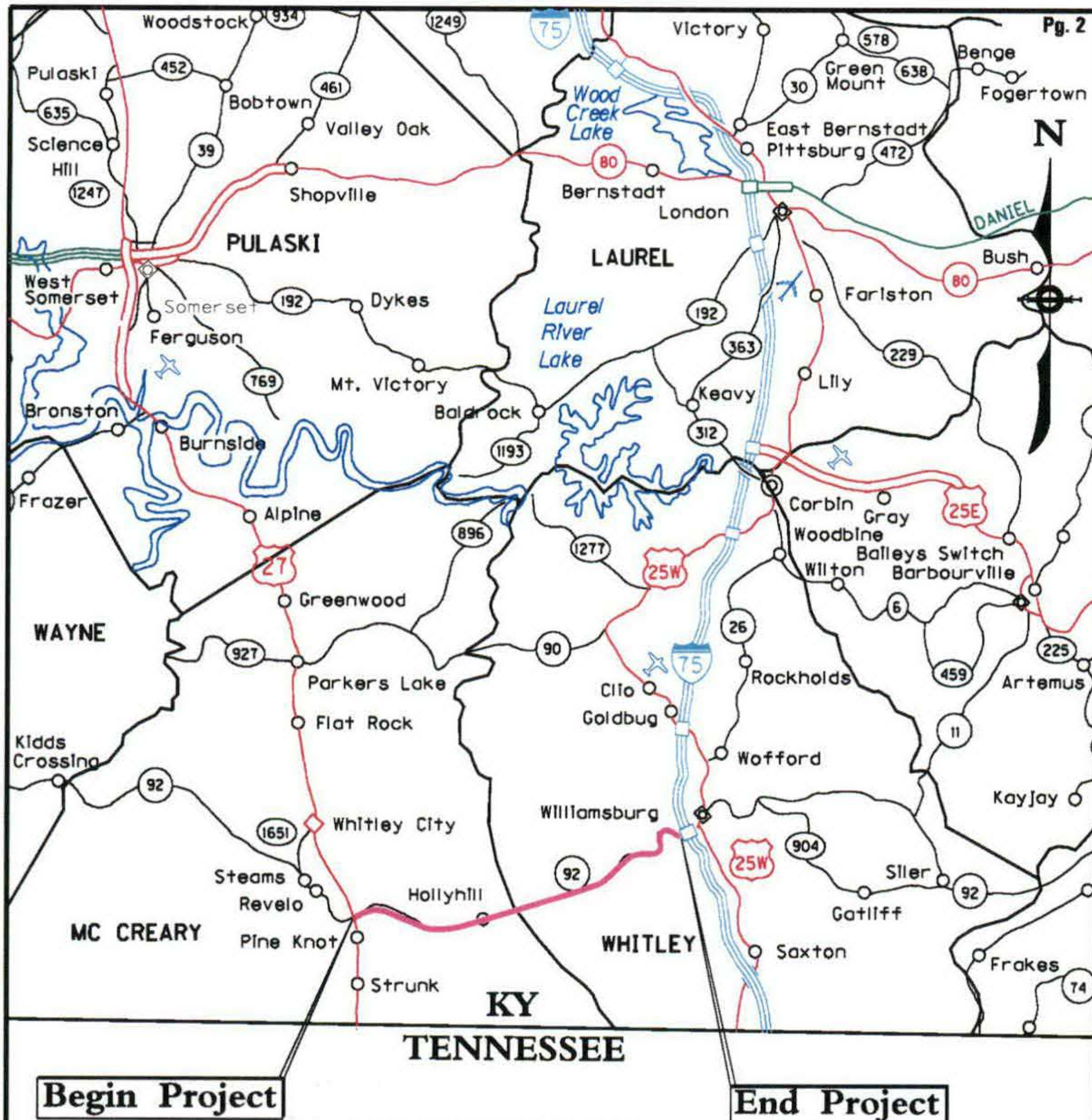
CHAPTER I

Introduction

This study evaluates ecological impacts involved with the reconstruction of KY 92, a winding, narrow, two-lane road, from US 27 near Pine Knot in McCreary County to Interstate 75 just south of Williamsburg, in Whitley County, Kentucky. The approximate total length of the proposed project is 32.3 kilometers(km) or 20.1 miles(mi). The project route goes through the Marsh Creek drainage area, the Hollyhill community, crosses Jellico Creek, and follows alongside Pleasant Run. It then crosses Bon Jellico Mountain to follow the Brier Creek drainage to Williamsburg.

The proposed project is located in southeastern Kentucky, in the southeastern section of the mountainous Eastern Kentucky Coal Field (Cumberland Plateau) physiographic region. Applicable United States Geological Survey (USGS) 7.5 minute topographic quadrangle maps are Whitley City, Hollyhill, and Williamsburg. Whitley County covers a land area of 440 square miles(mi^2), and is bounded on the north by Laurel County, on the south by Tennessee, on the east by Knox County, and on the west by McCreary County. McCreary County encompasses a land area of 427mi^2. It is bounded on the north by Pulaski County, on the south by Tennessee, on the east by Whitley County, and on the west by Wayne County. KY 92 is the only east-west route in the area. Figure 1 indicates project location.



VICINITY MAP

LOCATION MAP

FIGURE 1
McCreary–Whitley Counties, Ky.
KY 92 (Pine Knot – Williamsburg Road)
Vicinity & Location Maps

The project is designed to reconstruct and improve KY 92 to a four-lane highway. From US 27 to the McCreary/Whitley County line, KY 92 has two 9-foot(ft) lanes with two 3ft stabilized shoulders. Only 12 percent(%) of this section provides adequate passing sight distance. The posted speed limit is 55 miles per hour(mph), but the design speed is 50mph. From the County line to KY 296, KY 92 has two 9ft lanes with paved shoulders varying from 1 to 2ft in width; only 32% of this section has adequate passing sight distance. This section also has a posted speed limit of 55mph, but a design speed of 50mph. From KY 296 to the end of the project, KY 92 has two 10ft lanes with two 1ft paved shoulders; only 32% of this section provides adequate passing sight distance. This section has a posted speed limit of 45mph and a design speed of 55mph. It will be upgraded to two 3.6 meter(m) lanes with 3.6m paved shoulders and a 3.6m truck climbing lane where needed (Kentucky Transportation Cabinet, 1994).

A proposed transportation facility study generally consists of alternates connecting the origin and terminus through different alignment locations. This proposed highway would link US 27 at Pine Knot to I-75 at Williamsburg, a distance of approximately 20mi. Three alternates have been proposed in the McCreary County end of the project: alternates A, C, and D, as well as a combination of alternates C and D (Alternate B was dismissed from consideration early in the process). All alternates begin at Pine Knot and end at the McCreary-

Whitley County line. The Whitley County end of the project has three proposed alternates: E, F, G, with three combinations of the various alternates, as follows: E, F, & G, E & G, or F & G. All alternates begin at the county line and go to Williamsburg. Figures 2A-2I indicate alternates and combinations of alternates.

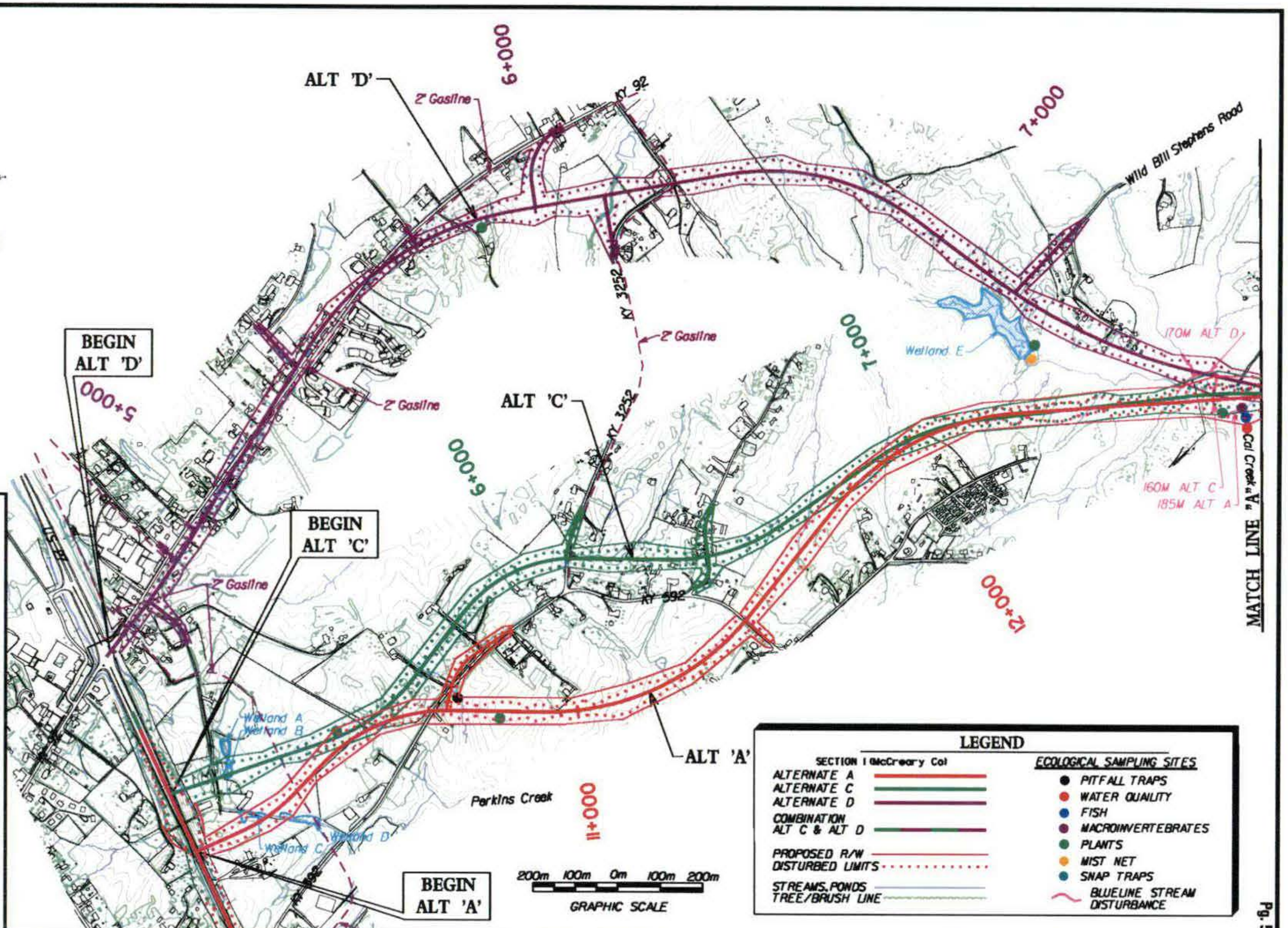


FIGURE 2A
McCreary-Whitley Counties, Ky.
KY 92 (Pine Knot - Williamsburg Road)
Project Alternates & Ecological Resource

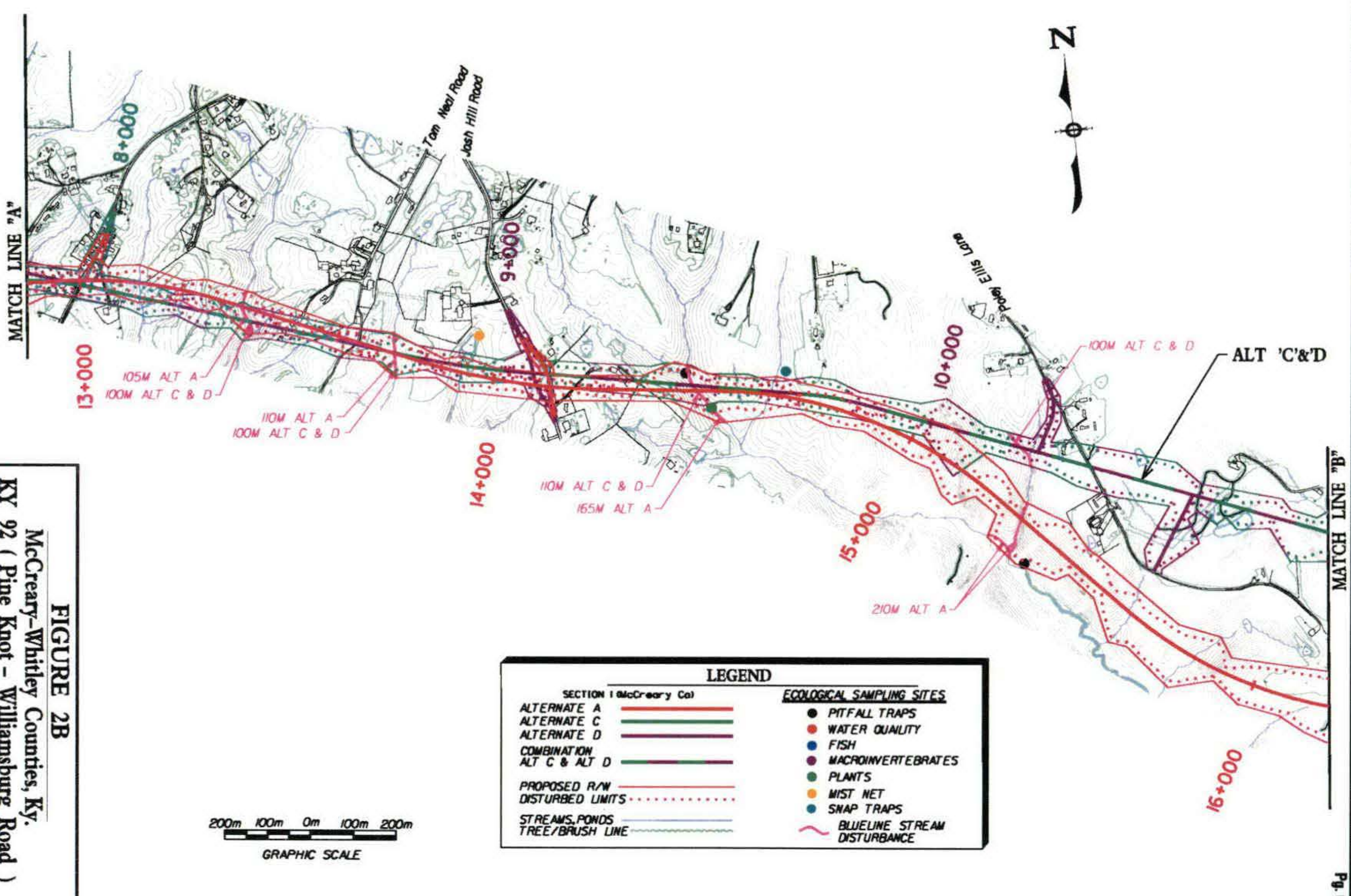


FIGURE 2B
McCreary-Whitley Counties, Ky.
KY 92 (Pine Knot - Williamsburg Road)
Project Alternates & Ecological Resource

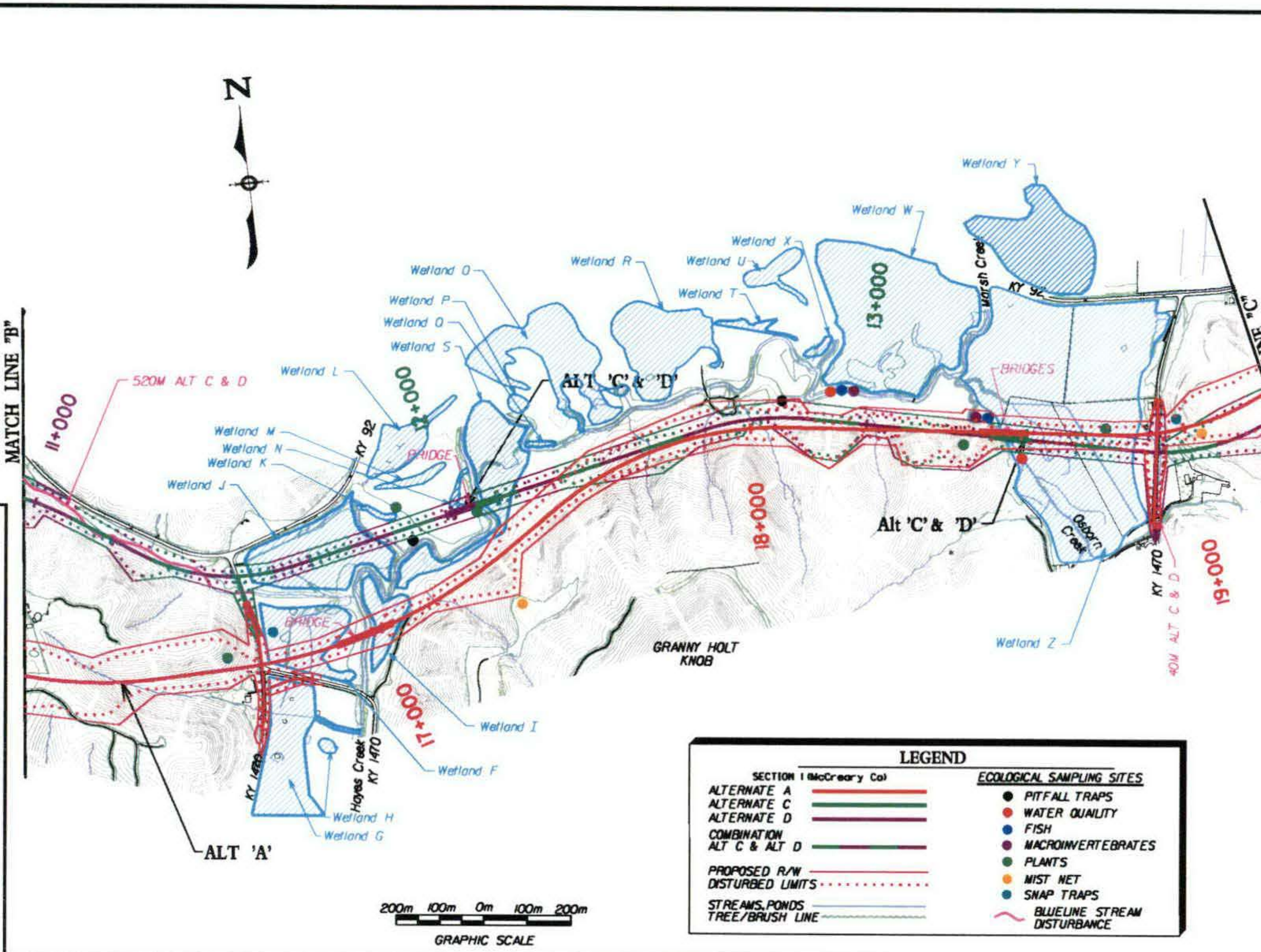


FIGURE 2C
McCreary–Whitley Counties, Ky.
KY 92 (Pine Knot - Williamsburg Road)
Project Alternates & Ecological Resource

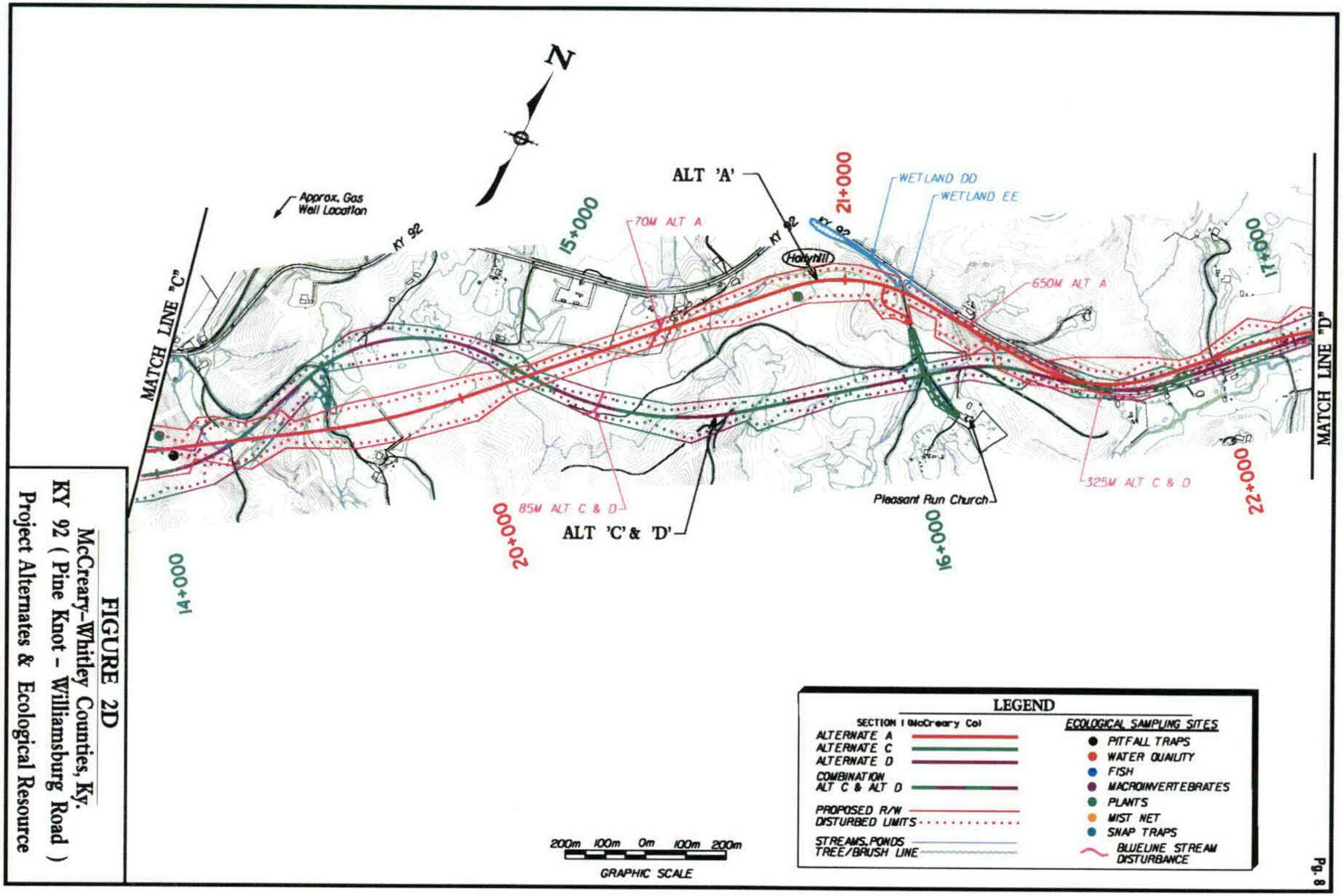


FIGURE 2D
McCreary-Whitley Counties, Ky.
KY 92 (Pine Knot - Williamsburg Road)
Project Alternates & Ecological Resource

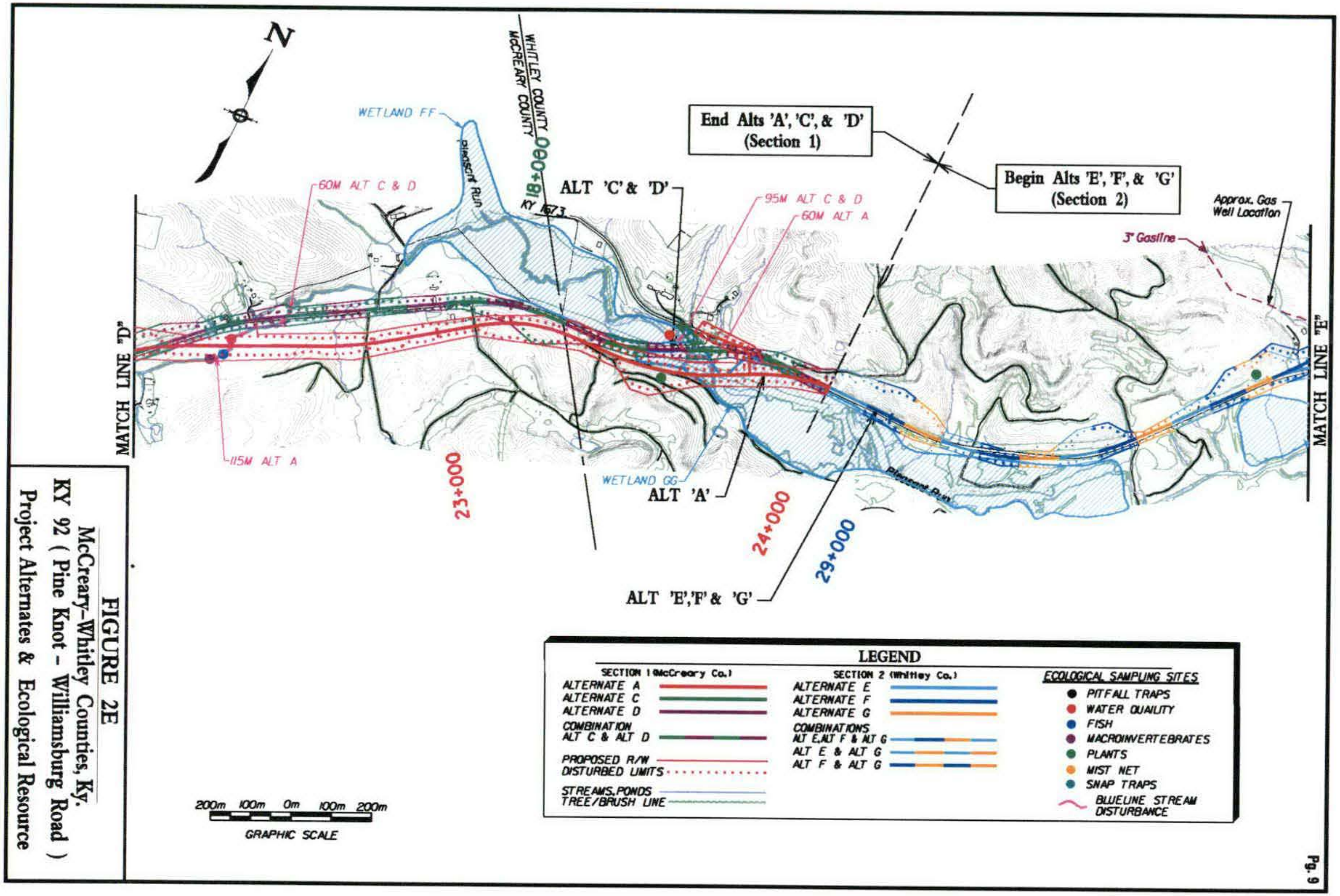


FIGURE 2E
McCreary-Whitley Counties, Ky.
KY 92 (Pine Knot - Williamsburg Road)
Project Alternates & Ecological Resource

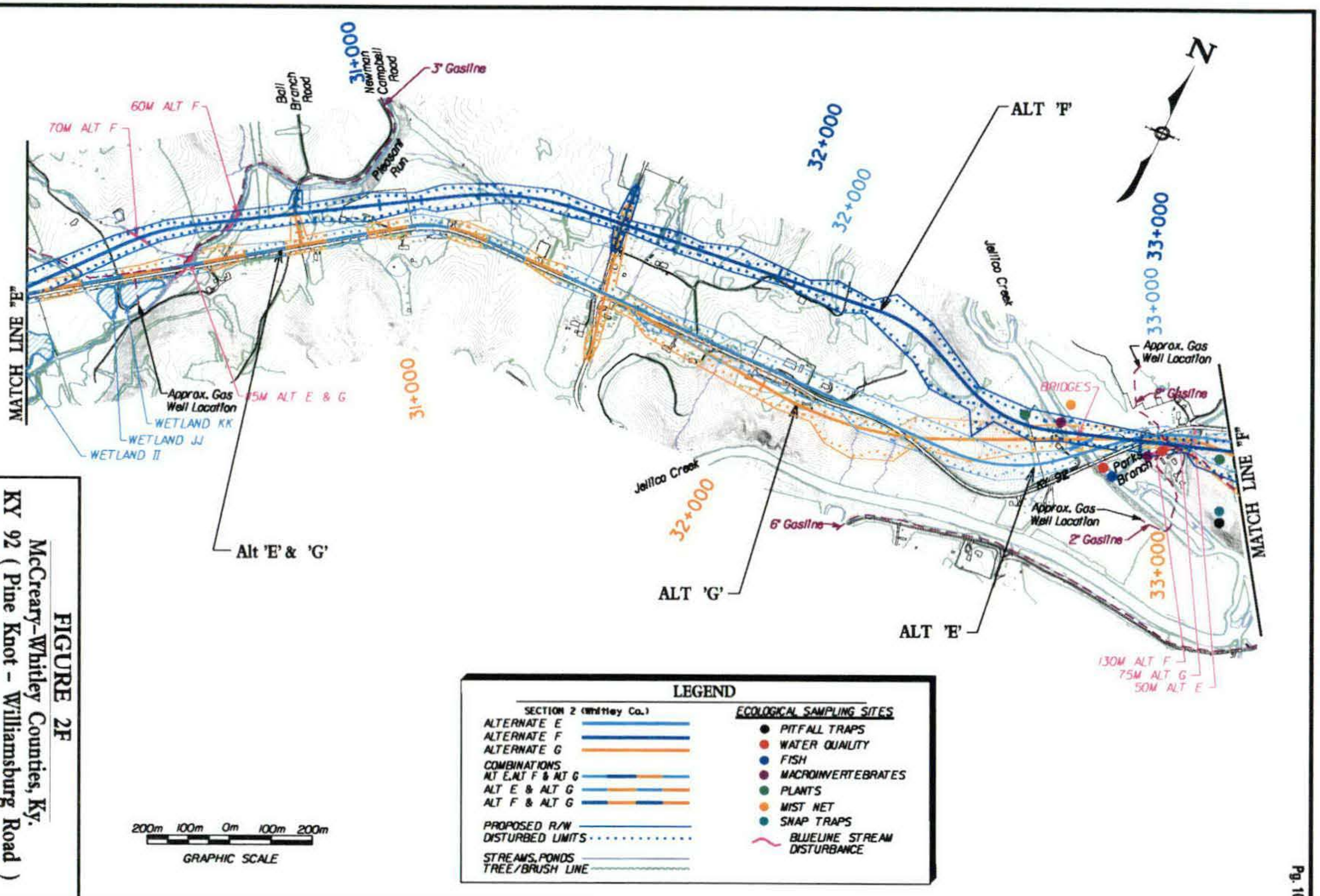


FIGURE 2F
McCreary-Whitley Counties, Ky.
KY 92 (Pine Knot - Williamsburg Road)
Project Alternates & Ecological Resource

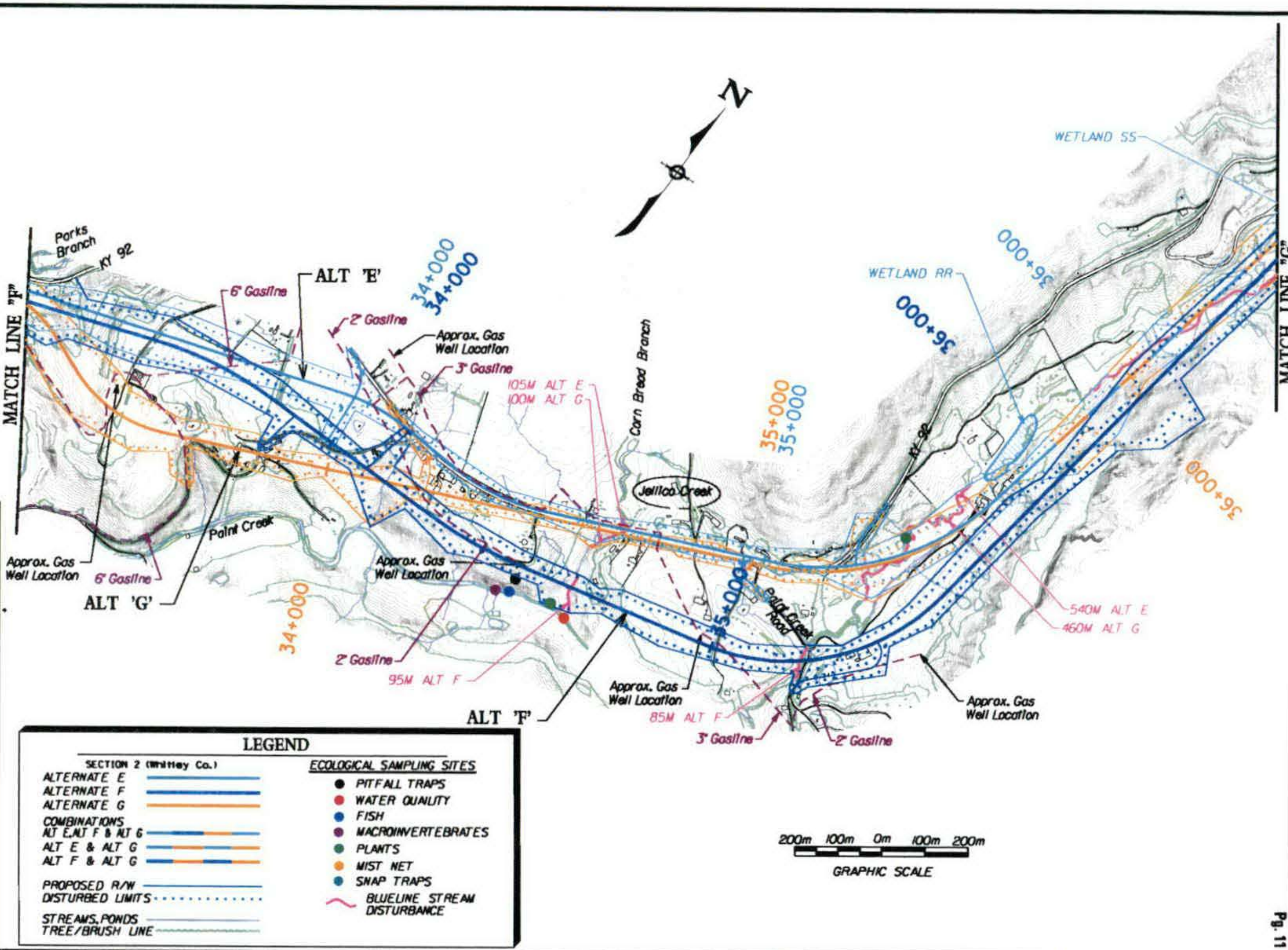
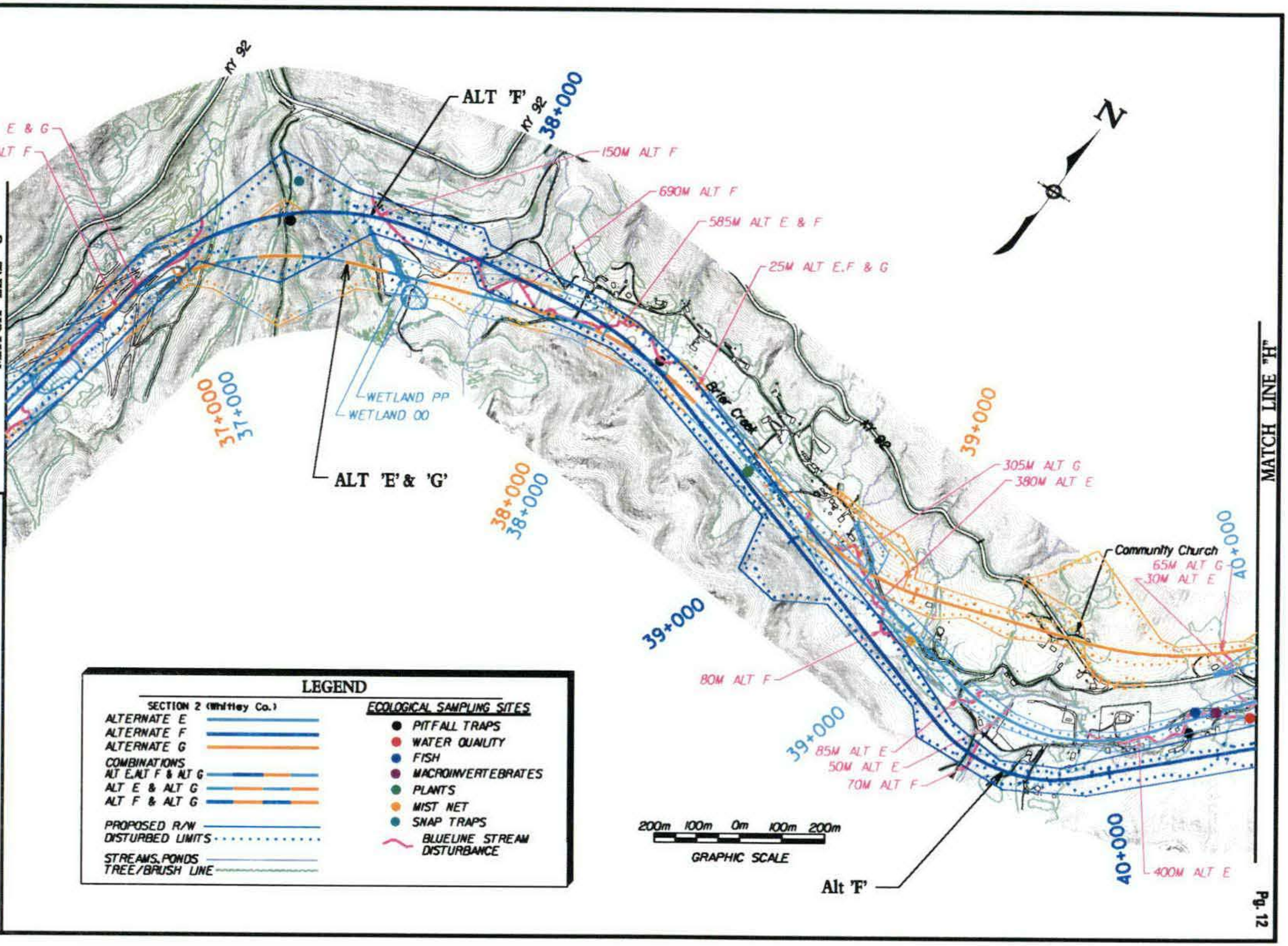


FIGURE 2G
McCreary-Whitley Counties, Ky.
KY 92 (Pine Knot - Williamsburg Road)
Project Alternates & Ecological Resource

FIGURE 2H
McCreary-Whitley Counties, Ky.
KY 92 (Pine Knot - Williamsburg Road)
Project Alternates & Ecological Resource



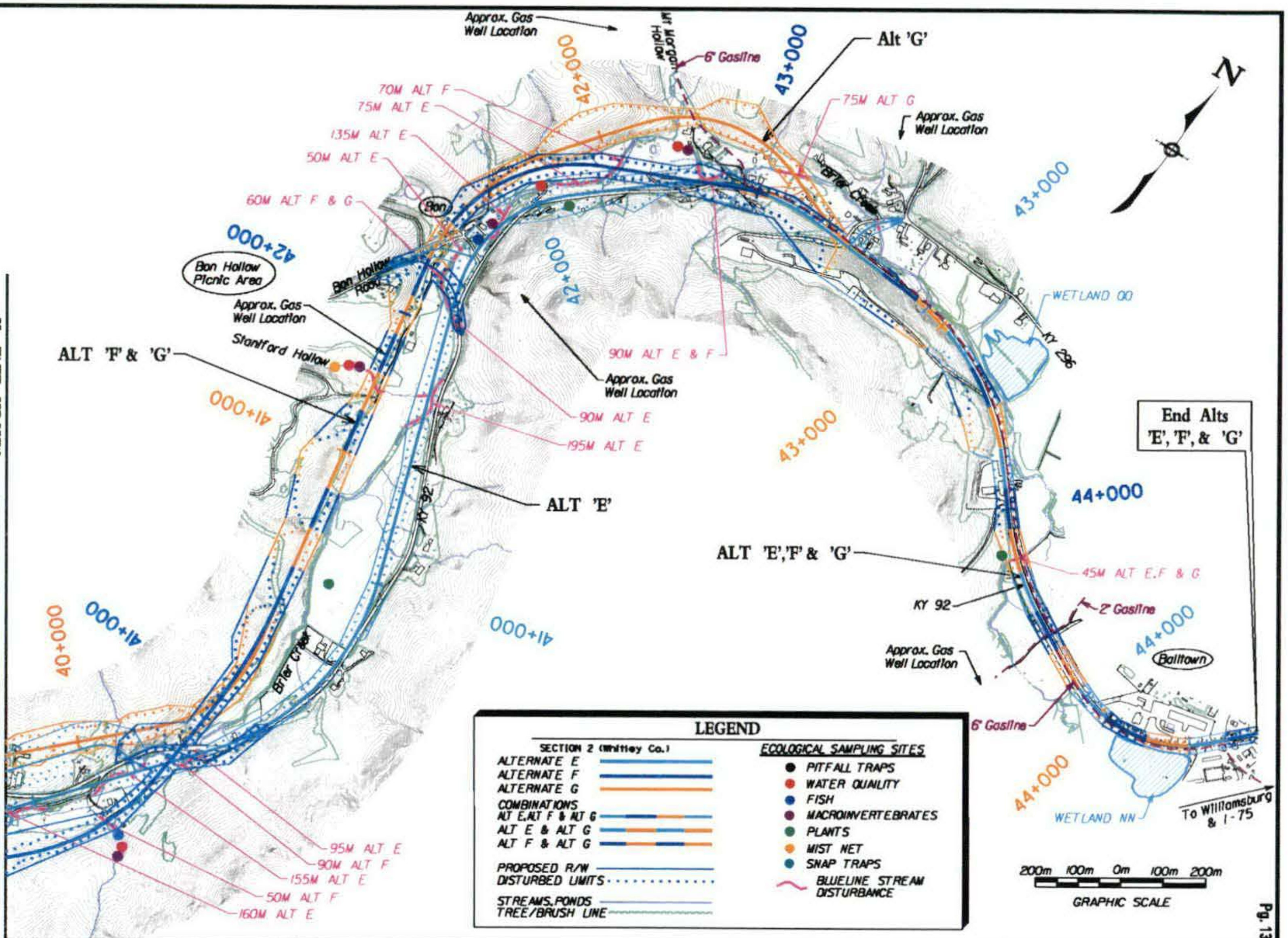


FIGURE 2I
McCreary-Whitley Counties, Ky.
KY 92 (Pine Knot - Williamsburg Road)
Project Alternates & Ecological Resource

The project lies within the generally westward-flowing Cumberland River watershed. The main tributaries flow in a northward direction, but the smaller streams flow east or west, forming a dendritic drainage pattern. The Pine Mountain fault is to the east and the Cumberland escarpment is to the west-northwest. This area contains high elevations and areas of great local relief, being completely dissected by stream erosion. Elevations range from approximately 960ft at the Cumberland River to 1968ft at the peak of Bon Jellico Mountain and over 2000ft at the summit of Ryans Creek Mountain. Many mountain tops in the area are 1800-2000+ft above mean sea level (MSL); however, many have now been leveled by areal strip mining. Rock formations are Quaternary alluvium and middle and lower Pennsylvanian Age sandstones of the Breathitt and Lee Formations (McGrain, 1983; US Geologic Maps, 1964, 1967). The Quaternary alluvium is approximately 20ft thick, and consists of sands, silts, gravels, and boulders. Talus slopes are situated at the base of most hills. The Pennsylvanian Formations consist of sandstone, shales, and coals. The regional dip, replete with several known faults, is approximately 40ft/mi to the southeast.

Four soils associations occur in the project corridor area. A soil association is a landscape with a distinctive proportional pattern of soils, consisting normally of one or more major soils and at least one minor soil. The soils of the Clymer-Dekalb Association are moderately deep to deep, well-drained to somewhat excessively-drained, gently rolling to moderately steep soils on plateaus and side slopes. This association occurs in the vicinity of Pine Knot in McCreary County at the beginning of the project area. The deep, gently-sloping Clymer soils form about 65% of the association and occur on broad ridgetops. The moderately-deep, excessively-drained Dekalb soils form 20% of the association. The minor soils form the remaining 15% of the association. These include the moderately well-drained Cotaco and Philo soils along stream channels, Tate soils on side slopes, and Wellston, Tilsit, and Muse soils on ridgetops.

The Muse-Wellston-Trappist Association occurs midway through the project. These are deep, well-drained soils on rounded ridgetops and convex side slopes of intermittent streams. This association occurs as a narrow, north-south belt extending from Spruce Creek in Whitley County through McCreary County to the state line. Muse soils make up 60% of the association, the Wellston soils 20%, Trappist soils 10%, and minor soils the remaining 10%. The Muse and Trappist soils occur on the side slopes, narrow ridges, and small knobs on broad ridgetops. Wellston soils occur on the broad, smooth ridgetops. Minor soils include Clymer and Dekalb soils on ridgetops, and Tate soils on side slopes near scattered outcrops of rock. Most of this association is forested, with yellow pine and hickory being dominant on most ridgetops and south-facing slopes. Mixed oaks are dominant on most of the north-facing slopes.

The Marsh Creek floodplain area, along with portions of the Jellico Creek and Cumberland River floodplains, are covered with soils of the Atkins-Pope-Tate Association. These are deep, poorly-drained to well-drained, nearly-level to gently-sloping soils. The Atkins and Pope soils together make up about 30% of the association, the Tate soils 10%, and minor soils the remaining 60%. Percentages of the major soils vary from one area to another. Along Marsh Creek most of the association consists of poorly-drained soils, while along Jellico Creek and the Cumberland River most of the soils are well-drained. The Atkins soils are poorly-drained silt loams of flood plains with a seasonal high water table. Pope soils are also flood plain soils, but are well-drained and have variable texture. The loamy Tate soils are situated higher and are well-drained. They occur on terraces and are generally not subject to annual flooding. Minor soils of this association are the Huntington, Philo, and Stendal on flood plains, and the Allegheny, Captina, Robertsville, Tyler, and Elk soils on stream terraces.

The Muse-Shelocta Association occurs through much of the Whitley County end of the project area. These are deep, well-drained, very stony, steep soils on the rough mountainsides of the Jellico Mountain range. Many streams dissect this association, and areas of sandstone cliffs are common. The Muse soils make up 60% of the association and occur on smooth to convex parts of the mountainsides. Shelocta soils make up 25% of the association and occur on smooth to concave areas, usually on north-facing slopes and the lower parts of slopes. Minor soils are the Weikert, Gilpin, and Trappist, occurring on ridgetops and steep side slopes. Renox soils occur in north-facing coves at an elevation of about 1,500ft. Most of this association is forested; hickories, black gum, chestnut oak and other hardwoods are found on ridgetops and south-facing slopes, while north-facing mountainsides host tulip poplar, northern red oak, and buckeye.

Soil features limiting land use for roads are steepness, seasonal high water table, flooding, depth to rock, stoniness, and erosion. Most areal soils have moderate to severe limitations (Natural Resources Conservation Service Soil Survey, McCreary-Whitley Area, Kentucky, 1970). Many areas adjacent to the existing highway have highly erodible soils. There are two hydric soils in the project area: Atkins silt loam (AtB) and the Robertsville silt loam (Re). These soils are situated along the Marsh Creek drainage area, where significant wetlands occur. Other soils of importance in the project area include several "Prime and Unique Farmland Soils"(Natural Resources Conservation Service, 1995), most of which occur in or near floodplains. They are: Atkins silt loam (AtB), Captina silt loam (CaB), Clymer fine sandy loam (ClB), Cotaco silt loam (Ct), elk silt loam (Ek), Philo fine sandy loam (Pf), Philo silt loam (Ph), Pope soils (PsA), Tilsit silt loam (TpB), Tyler silt loam (Ty), and Wellston and Tilsit silt loam (WtB).

The local climate of McCreary and Whitley counties is temperate, with moderately cold winters and warm, humid summers. Average monthly temperatures are warmer at lower elevations than at higher elevations. The average growing season for this region is about 185 days, while annual precipitation is approximately 47 inches. About 85% of the McCreary-Whitley county area is forested, mainly with deciduous trees. Braun (1950) and Wharton and Barbour (1979) included this region of Kentucky in the Mixed Mesophytic Forest. Mixed mesophytic forests of the Cumberland Plateau have many dominant species of trees in the canopy layer. These include American beech (*Fagus grandifolia*), yellow poplar (*Liriodendron tulipifera*), basswood (*Tilia heterophylla*), sugar maple (*Acer saccharum*), American chestnut (*Castanea dentata*), sweet buckeye (*Aesculus octandra*), red oak (*Quercus borealis*), white oak (*Quercus alba*), and eastern hemlock (*Tsuga canadensis*). Additional abundant species include white ash (*Fraxinus americana*), red maple (*Acer rubrum*), sour gum (*Nyssa sylvatica*), black walnut (*Juglans nigra*), chestnut oak (*Quercus montana*), black oak (*Quercus velutina*), slippery elm (*Ulmus rubra*), black cherry (*Prunus serotina*), hickory (*Carya* spp.), sweet birch (*Betula lenta*) and yellow birch (*Betula lutea*). Because of the large number of dominants in this climax, the composition and abundance of dominants will vary greatly from place to place (Braun, 1950). Braun placed the American chestnut in the dominant category, but now, because of chestnut blight, they are rare.

Smaller trees that seldom attain canopy position are: flowering dogwood (*Cornus florida*), bigleaf magnolia (*Magnolia macrophylla*), umbrella magnolia (*Magnolia tripetala*), sourwood (*Oxydendrum arboreum*), redbud (*Cercis canadensis*), ironwood (*Carpinus caroliniana*), American holly (*Ilex opaca*) and serviceberry (*Amelanchier arborea*). Common shrubs in the Mixed Mesophytic Forest include spicebush (*Lindera benzoin*), witch hazel (*Hamamelis virginiana*), pawpaw (*Asimina triloba*), maple-leaved viburnum (*Viburnum acerifolium*) and alternate-leaved dogwood (*Cornus alternifolia*) (Braun, 1950).

Most of the forested regions of McCreary and Whitley Counties are within the Daniel Boone National Forest proclamation boundary; for this reason, the US Forest Service (USFS) wildlife biologist Linda Perry, and District Ranger Mike Melton, were contacted for documentation of rare and endangered species in the project area.

Timber, natural gas and coal are the primary natural resources of this region. Because the alignments are located within the Williamsburg and Saxton Gas Fields, a number of active gas wells could be affected by this project. There are also abandoned deep mines, and both reclaimed and unreclaimed strip mines along the proposed alternates.

This project was coordinated by written letter with a number of different agencies. The U.S. Fish and Wildlife Service (USFWS) was consulted pursuant to Section 7(c) of the Endangered Species Act of 1973 for information on federally protected species potentially affected by the project. Kentucky's Natural Resources and Environmental Protection Cabinet-Division of Water (NREPC-DOW) was contacted for water quality impacts, general groundwater information, wild and scenic rivers, and other significant aquatic concerns. The Data Processing Branch of the Natural Resources and Environmental Protection Cabinet (NREPC) provided National Wetlands Inventory (NWI) maps. The Kentucky Department of Fish and Wildlife Resources (KDFWR) and the Kentucky State Nature Preserves Commission (KSNPC) were contacted for endangered species occurrences and critical natural areas information. Soils information was obtained from the Natural Resources Conservation Service. The U.S. Army Corps of Engineers (USACOE) provided floodplain and necessary permit information. The USACOE was consulted regarding known project area wetlands and any necessary mitigation requirements. The topographic and soils maps, present and proposed listings of endangered species, as well as aerial photographs, were studied to plan field activities.

Federal and state laws require the Kentucky Transportation Cabinet to obtain the appropriate permits and certifications before beginning highway construction involving United States waters (lakes, rivers, streams, or wetlands). Permits required for this project include a Water Quality Certification 401 Permit from Kentucky's DOW in accordance with Section 401 of the Clean Water Act. This certification must be obtained before conducting any activity that may result in a pollutant discharge into waters of the United States. Another required permit is the Dredge and Fill permit issued by the USACOE pursuant to Section 404 of the Clean Water Act. These permits must be obtained prior to conducting any activity that obstructs or alters any United States waters or navigable waters by excavating, filling, or crossing any such waters. According to information received through correspondence with the Nashville District of the USACOE's Regulatory Branch, authorization will be needed for this project.

The flora of McCreary and Whitley Counties has been studied by a number of investigators. McCoy (1938), Beal and Thieret (1986) and Meijer (1992) cited numerous vascular plant records from McCreary and Whitley Counties. McCoy (1938) and Cranfill (1980) listed fern records for Kentucky. Rogers (1941) studied the flora of McCreary County, and Braun (1943) included numerous records of monocots and dicots for both counties. Beal and Thieret (1986) surveyed the aquatic and wetland plants of Kentucky, and included numerous county records for southeastern Kentucky. Meijer (1992) surveyed plant collections at the University of Kentucky and produced a preliminary "Spring-Summer Flora of Kentucky".

McCreary and Whitley County herpetofauna have been reported by Garman (1894); Funkhouser (1925); McIntyre (1926); Burt (1933); Dury and Williams (1933); Adams (1939); Dury and Gessing (1940); Barbour (1950, 1956, 1960, 1971); Gordon (1952); McConkey (1954); Conant

(1958, 1975); Collins (1962); Barbour and Ernst (1971); Palmer-Ball et al. (1988); and Campbell et al. (1989, 1994). Conant and Collins (1991) gave species descriptions and current range maps for regional amphibians and reptiles. Stephens (1985) conducted a detailed survey of the amphibians and reptiles of McCreary County. The USFS (1990) listed several rare herpetofauna from the project impact area.

The breeding birds of these counties have been included by Palmer-Ball in the Breeding Bird Atlas (1996). Mengel (1965) and Monroe et al. (1988) provided additional county records. R.T. Peterson (1980) provided a complete list of the birds of the region. Mammal records for McCreary and Whitley Counties have been provided by several authors, including Funkhouser (1925), Barbour and Davis (1974), Davis and Barbour (1979), Caldwell and Bryan (1982), Houtcooper (1982), Barclay and Parsons (1983), Palmer-Ball et al. (1988), Campbell et al. (1989, 1990, 1994), Bryan (1991) and Meade (1992). Burt and Grossenheider (1980) included species descriptions and current range maps.

Jordan and Swain (1883) were the first to report on the ichthyofauna of McCreary and Whitley Counties. Their specimens of *Etheostoma nigrum susanae* and *E. flabellare* were recorded from Brier Creek in the project impact area. Garman (1894) included these same fish records and added a salamander, *Ambystoma punctatum* (= *A. maculatum*), from McCreary County. Starnes and Starnes (1978) documented *Phoxinus cumberlandensis* as occurring in the

Upper Cumberland River drainage. They (1979) also studied the distribution of *E. nigrum susanae* in the upper Cumberland River drainage, and found it to be rare in the streams of McCreary and Whitley Counties. O'Bara (1985) identified *Phoxinus cumberlandensis* from the Jellico Creek drainage in Whitley County. Burr and Warren (1986) surveyed Kentucky's fish fauna, including numerous records of fishes from the study area. Page and Burr (1991) provided species descriptions and range maps for regional fishes.

CHAPTER II

Materials and Methods

An effort was made to identify all natural communities, special habitats, and rare and/or endangered species in the project area. Data were collected from numerous sites along the entire project corridor, which included 500ft lanes on each side of proposed alternates. Collection permits were obtained from KDFWR.

Vascular plants were documented during field visits in the growing seasons of 1995 and 1996. Due to the project size, it was not possible to sample all the vegetation. Data were obtained by first identifying the various habitats within the project corridor. The identified habitats included upland fields, upland forests, riparian areas, and wetlands. In order not to miss rare and/or endangered plants, each proposed right-of-way was walked, and plants within the right-of-way were recorded. Unusual, rare and/or endangered plants outside the right-of-ways were also recorded. Those species not identified in the field were collected, pressed, and returned to the Morehead State University (MSU) herbarium. Lab identification of plants was aided by the use of a binocular dissecting scope and various plant keys. Descriptions, range maps and dichotomous keys for identification were provided by Gleason (1963), Pringle (1967), Justice and Bell (1968), Peterson and McKenny (1968), Strausbaugh and Core (1970-1977), Wharton and Barbour (1973, 1979),.Cranfill (1980), Key(1982), Fernald (1986), Petrides (1986), and Haragan (1991).

Terrestrial faunal investigations involved recording live species by direct observation, searching for faunal evidence (tracks, scats, bedding places, skeletal remains in discarded bottles and cans, and road kills), turning over rocks and logs, and setting a series of pitfall and snap traps along the project corridor. Approximately 200 pitfall traps (32-ounce plastic cups) were placed at ground level along rocks and decaying logs in the study area. Traps were placed at or near KY 592 near Pine Knot, Hobert Perkins Road, Newman Campbell Road, Marsh Creek swamp at KY 592, Paint Creek falls, KY 1470 at Osborn Creek, Jellico Creek Road, Old Jellico Creek Road, Bon Jellico Mountain, reclaimed strip mines on Brier Creek, Brier Creek, and Lower Brier Creek. Dirt was piled around the edges of the pitfall traps so that no space remained open between the cup and the surrounding soil. Formalin solution (1 part 37% formaldehyde/9 parts water) was placed in the bottom of the traps, filling each to about one-third capacity, so that complete specimens of small mammals and herps could be obtained. All pitfall traps were left in the ground for several weeks at each site. Seventy-five snap traps (mouse traps) were also set in different habitats along the project route, including Hobart Perkins Road, Marsh Creek near KY 592, Marsh Creek bridge at KY 92, Osborn Creek, Paint Creek, and at Marsh Creek at Neal Road. Specimens collected were returned to the MSU laboratory for identification and measurements.

Mammals were examined for total length, tail length, hind foot length, ear length, body weight and sex. In some cases the teeth were examined. It was also determined whether or not the females were gravid. All mammals trapped in pitfall traps and other mammal species observed in the project area were identified according to Barbour and Davis (1974). Herpetofaunal measurements were not recorded. These were identified according to Conant and Collins (1991).

Bird species were observed throughout the project corridor as I conducted all other studies. Identification of species sighted was according to Peterson (1980) and Palmer-Ball Jr. (1996).

The study area was also searched for bat habitat and rare bats, because rare and/or endangered bats have been reported from this region. All clifflines were checked for rock shelters, potential bat habitat, and the corridor area was searched for old deep-mine entrances and caves. Mist-netting was conducted, as described by Cope et al. (1978) and Miller and Kessler (1980). Mist nets were set up over area streams and ponds. Netting sites included a wetland near Pine Knot and a pond near Tom Neal Road in September, 1995; a strip mine site atop Granny Holt Knob in May, 1996; Ryans Creek Mountain in July, 1996; Jellico Creek in late May, 1996; Staniford Hollow in September, 1996; and Brier Creek in May, 1997. Mist nets (2.6x12m) of 36mm black nylon mesh were attached to 24ft lengths of aluminum poles. Nets were placed two or three high in order to increase capture probability. Nets were watched from dusk to midnight. When captures were made, mist nets were lowered and captured specimens were removed from the net. All bats were identified by species, gender, and reproductive condition (gravid or non-gravid). Captured specimens were then marked on the wing with correction fluid, and released. This white spot allowed any recaptures to be easily recognized.

Project area fishes were sampled by using nylon minnow seines (4x20 feet, of 1/8 inch mesh). Sampled streams included Cal Creek, Osborn Creek, Marsh Creek, Paint Creek, Jellico Creek, Pleasant Run and Brier Creek. Several other smaller tributaries in the project area were examined, but not seined because of their small size. Past strip mining severely impacted some of these streams, and acid runoff was noticeable in several regions. Fishes of this region appear to be ready to make a comeback, except in Pleasant Run.

Seining techniques included stretching the seine across riffles and kicking the rocks, gravel and sediments of the substrate. In pool regions, the seine was dragged across the bottom in open water or through areas with vegetation. Another capture technique was to hold the seine against the bank in deeper water, beneath tree roots, and then thrust a stick under the roots to bring fish out of hiding. Seining was conducted in the areas of greatest impact (eg., where a bridge or culvert would be required). In each stream, two riffles, runs and pools were sampled intensively, if possible. In areas where two riffles, runs and pools could not be sampled, a 100ft segment of the stream was sampled for approximately 60 minutes, a method recommended by NREPC-DOW (1993). A random sample of fish species was collected for each stream, and specimens of each species were preserved in 10 percent buffered formalin; BHT (Butylated Hydroxytoluene) was added to the formalin for color preservation. The number of each species captured was documented so that species diversity could be established.

Fish samples were returned to the MSU laboratory for further identification. In the lab, fish specimens were rinsed with tap water and placed on large dissection trays for sorting to species level. A binocular dissecting microscope was often used to examine external fish anatomy (eg., scale counts, coloration, lateral line shape). Species and number of individuals were recorded; any rare, threatened or endangered species were documented, and appropriate agencies were notified. Fish specimens were then discarded or preserved in clean formalin and added to the MSU Vertebrate Collection. Kentucky Fish and Wildlife Resources staff (Doug Stephens and another staff member of Williamsburg and Tim Slone of Frankfort) provided a backpack electroshocker to examine the fishes of Marsh and Jellico Creeks in more detail. Nomenclature from Burr and Warren (1986) was used.

The aquatic macroinvertebrate communities were examined by using nylon muslin kick nets (approximately 12x24in). Collections were made at Cal Creek, Perkins

Creek, Marsh Creek, Osborn Creek, Pleasant Run, Jellico Creek, Roberts Branch (tributary of Paint Creek), Paint Creek, Staniford Hollow, Mt. Morgan Hollow and Brier Creek. All of these streams may be impacted by the reconstruction of KY 92. Generally, kick net sampling was conducted randomly over a 100ft riffle-run section of the streams. In some of the lower order streams, two or three kick-net samples sufficed. The net was placed in mid-riffle, and an area of approximately onem^2 directly upstream from the net was vigorously kicked. Large rocks were also hand-rubbed, allowing macroinvertebrates to wash into the net. In addition, we conducted a one man-hour visual search of rocks from both pool and riffle areas and hand picked aquatic insects. The aquatic insects were not sorted in the field, but were killed in a 10 percent formalin solution and returned to the MSU laboratory for sorting and identification. Laboratory sorting was done with the aid of a dissecting scope against a white background, using fine-tipped dissecting forceps. Samples were finally preserved in 70% ethanol and labeled. All macroinvertebrate identifications were made to the lowest possible level using current taxonomic information (Borrow and White, 1970; Hobbs and Jass, 1988; Merritt and Cummins, 1988; and Peckarsky, Fraissinet, Penton, and Conklin, Jr., 1993). In areas where freshwater mussels were observed, attempts were made to identify live specimens and return them to the substrate. Empty shells were also collected and returned to the laboratory for cataloging, following Cummings and

Mayer (1992), Oesch (1984), and Williams and Schuster (1989).

Wetlands were classified using the criteria outlined in the ACE Wetlands Delineation Manual (1987). These criteria included the presence of hydric soils, hydrophytic vegetation, and wetland hydrology. All three criteria must be present for a given area to be considered a wetland. Hydric soils are defined as soils that are inundated or saturated for a long enough time to produce anaerobic soil conditions, and under natural conditions, would support hydrophytic vegetation. Soil types were determined using soil corings made with a 36-inch tube sampler soil probe, and the aid of a Munsell soil color chart (1992). Reduced oxygen during periods of permanent or frequent inundation or saturation produces changes in the soil color. Soils become gleyed, dark gray, or black during long periods of flooding; during moderate periods of inundation, the soil may become gray with darker mottles. When these conditions exist, the soil may be classified as hydric. Soil colors were compared to the hue, chroma and value color charts to determine if the sampled soils were hydric. Reviews of NWI maps and NRCS data were completed as part of this study. Collected data on wetland plants, soil type and hydrology were compiled on USACOE Data Form I.

Hydrophytic plants are those typically adapted to saturated or moist soil conditions and periodic or permanent inundation. The plant classification system developed by the U.S. Fish and Wildlife Service was used to determine hydrophytic vegetation. Indicator criteria included: obligate plants (probability of occurring in wetlands 99% of the time), facultative wetland plants (probabilty of occurring in wetlands 67-99%), facultative plants (estimated probability of occurring in wetlands 33-67%), facultative upland plants (probability of occurring in wetlands 1-33%), and obligate upland plants (estimated probability of occurring in wetlands <1%).

Wetland hydrology was determined by field indicators such as ponded water, water marks, drift lines, sediment deposits and/or saturated soils.

Water quality was determined by HACH water analysis procedures and a DREL/2000 portable spectrophotometer, following guidelines in the HACH DR/2000 Spectrophotometer Handbook for most parameters measured. Water quality parameters included temperature, dissolved oxygen, total alkalinity, turbidity, pH, total dissolved solids, color, nitrate nitrogen, sulfate, ammonia nitrogen, reactive phosphorus (orthophosphate), acidity, chloride, and hardness, as well as discharge. The pH was determined with the use of an ATI Orion (model 106) pH meter, and conductivity was established with the use of the ATI Orion (model 116) conductivity meter. A Hanna Instruments TDS meter (model 8684) determined total dissolved solids and water temperature. All analyses and measurements were conducted on-site, and physical stream characteristics were measured directly in the field. The aquatic macroinvertebrate analysis also aided in evaluating the water quality. Water quality data were collected from Cal Creek, Perkins Creek, Marsh Creek, Osborn Creek, Pleasant Run, Paint Creek, Roberts Branch, Jellico Creek, Staniford Hollow, and two sites on Brier Creek.

A survey for the federally endangered red-cockaded woodpecker (RCW) was conducted during October 1996, along KY 92, in a mature pine stand and in April, 1998 at Staniford Hollow. These surveys began at dawn and lasted for two hours. They involved sitting still in the pine stands and observing all birds that flew from the trees upon awakening, as well as listening for the distinctive call of the woodpecker. Historically, this species is known from the area.

CHAPTER III

Results and Discussion

A. Terrestrial Habitats

The project corridor has rich floral communities, with several rare species known from the general area. Most of it is forested, with yellow pine and hickory being dominant on most ridgetops and south-facing slopes. Mixed oaks are dominant on most north-facing slopes. Much of the project corridor area is covered by intermittent wetlands and their associated plants, especially in the Marsh Creek drainage and the Pleasant Run area. Three hundred and ninety (390) plants from 80 different families were identified during field investigations. For the purposes of this report, the project area has been divided into the following plant communities:

1. Forested Wetlands

Swamps and floodplain forests are dominated by trees and shrubs. Forested wetlands are hydrologically open systems characterized by a high ground water level. The hummocky nature of the forest floor creates temporary water-filled pools, important breeding grounds for an array of reptiles and amphibians, as well as nesting grounds for various bird species. Such forests can tolerate flooding 3-4 months of the year, but more frequent flooding results in forest decline. If the proposed project caused water to back up and flood the area, the changed hydrology would soon suffocate the forested wetland community. Forested wetlands are often groundwater recharge areas that serve to control flooding and lower storm damage. They may filter water and remove pollutants, as well as provide valuable wildlife habitat. River birch was a dominant tree of the forested wetlands, as well as the American elm, red maple, swamp white oak and ash. Orchids (*Habenaria* spp.) were abundant, and the soapwort gentian frequently occurred in the wetland areas (See Figure 3).

Figure 3. Typical Forested Wetland Along Marsh Creek

2. Scrub/shrub Wetlands

Shrub swamps are often considered to be transitional communities between wet meadows and forested wetlands. Some functional roles of these plant communities include groundwater recharge, serving as water filters and pollution attenuators, reducing storm damage through flood control, and providing superior wildlife habitat. Emergent vegetation wetlands commonly occurred along the shrub swamp edges. Typical shrubs and young trees included alders, willows, buttonbush, and shrubby dogwoods. Alder shrub swamp areas with beaver dams occurred in the Pleasant Run area, and shrub wetlands were found along Marsh Creek, Hayes Creek, and Osborn Creek (See Figure 4).

Figure 4. Typical Scrub-shrub Wetland

3. Emergent Vegetation Wetlands

Wet meadows are important wetlands: they serve to control flooding, filter pollutants, and provide high quality wildlife habitat. Rushes and sedges were the more common plants found in emergent vegetation wetlands, and orchids (particularly *Habenaria* spp.) were often abundant. Sedges such as *Carex lurida, Carex frankii, Carex normalis, Carex crus-corvi, Carex lupulina,* along with blue-eyed grass (*Sisyrinchium angustifolium)*, reed canary grass (*Phalaris arundinacea*), and common Joe-pye weed (*Eupatorium fistulosum*) were frequently identified in the emergent vegetation wetland (See Figure 5).

Figure 5. Typical Emergent Vegetation Wetland

4. Hemlock-rhododendron Coves

Hemlock-rhododendron dominated areas occur in various sites along the project route, particularly in coves and along streams. The headwaters of Cal Creek, potentially impacted by alternates A and C, hosts areas of hemlock, rhododendron, and laurel, with understories of trailing arbutus, grapeferns, Jack-in-the-pulpit, Indian cucumber root, and various ferns. Paint Creek is a cold, fast mountain stream, replete with waterfalls and boulders. Vegetation there includes rhododendron, laurel, ferns, rattlesnake plantain, snowberry, maple, magnolias, and asters. Areas of Jellico Creek also are covered with the hemlock-rhododendron plant community (See Figure 6).

Figure 6. Hemlock-rhododendron Forest

5. Upland Hardwoods

Upland hardwood areas occurred on Bon Jellico Mountain, the Cal Hill area, Ryans Mountain, Granny Holt Knob, and along existing KY 92 near Pine Knot. Oaks dominated the landscape with common species including post and southern red oak, white oak, scarlet oak, black-jack oak, chinquapin oak, bur oak, chestnut oak, and pin oak. Other common trees were black gum, hickories, wild cherry, maples, sourwood, and some beech trees. The understory typically was strawberry bush, honeysuckle, blueberries, huckleberries, smilax, Virginia creeper, blue cohosh, azaleas, spotted wintergreen, teaberry, wild iris, trillium, heartleaf, various ferns and spring beauty (See Figure 7).

Figure 7. Upland Hardwood Forest

6. Riparian Areas

Riparian areas occur throughout the project area, particularly along Marsh Creek, Jellico Creek, the mouth of Cal Creek and Pleasant Run's associated streams. Vegetation along these streams included river birch, willows, sycamore, maples, sourwood, wild cherry, and redbud, with shrubs such as spicebush, hazelnut, strawberry bush, alder, and dogwood. The herbaceous layer typically had cane, Virginia bluebells, ragworts, and firepinks. The Brier Creek riparian area included tulip poplar, muscle tree, redbud, and American hornbeam. The herbaceous plants were ferns, trout lily, wild geranium, toothworts, trilliums, bloodroot, violets, and mayapple (See Figure 8).

Figure 8. Typical Riparian Area

7. Upland Farm Fields

There are farm fields near the project's beginning at Pine Knot, and scattered throughout the project area. Vegetation in these fields included meadow fescue, various clovers, Queen Anne's lace, plantains, Venus' looking glass, orchard grass, daisies, goldenrods, milkweed, eupatoriums, mistflower, vetches, and ironweed (See Figure 9).

Figure 9. Upland Farm Field

TABLE I lists all plants collected and/or identified from the study area. Each plant is alphabetized by taxon, rather than habitat because of obvious overlaps and inconsistencies.

TABLE I. Floral Species Identified during Field Investigations for the KY 92 Improvement Project.

Pteridophyta	(Ferns and Fern Allies)
Adiantum pedatum	Maidenhair Fern
Asplenium pinnatifidum	Pinnatifid Spleenwort
Asplenium platyneuron	Ebony Spleenwort
Asplenium rhizophyllum	Walking Fern
Athyrium asplenioides	Southern Lady Fern
Athyrium thelypterioides	Silvery Spleenwort
Botrychium dissectum	Evergreen Grape Fern
Botrychium dissectum forma obliquum	Evergreen Grape Fern
Botrychium virginianum	Rattlesnake Fern
Cystopteris fragilis	Fragile Fern
Dennstaedtia punctilobula	Hay-scented Fern
Dryopteris marginalis	Marginal Shield Fern
Lorinseria areolata	Net-veined Chain Fern
Lycopodium digitatum	Ground Cedar
Lycopodium lucidulum	Shining Clubmoss
Lycopodium obscurum	Tree Clubmoss
Lygodium palmatum	Climbing Fern
Onoclea sensibilis	Sensitive Fern
Osmunda cinnamomea	Cinnamon Fern
Osmunda regalis	Royal Fern
Polypodium polypodioides	Resurrection Fern
Polypodium virginianum	Common Polypody

TABLE I (Continued)

Polystichum acrostichoides	Christmas Fern
Pteridium aquilinum	Braken Fern
Thelypteris noveboracensis	New York Fern
Gymnospermae	**(Seed Plants)**
Cupressaceae	**(Cypress Family)**
Juniperus virginiana	Red Cedar
Pinaceae	**(Pine Family)**
Pinus echinata	Shortleaf Pine
Pinus rigida	Pitch Pine
Pinus strobus	White Pine
Pinus virginiana	Virginia Pine
Tsuga canadensis	Hemlock
Angiospermae-Monocotyledoneae	**(Monocots)**
Alismataceae	**(Water Plantain Family)**
Alisma subcordatum	Common Water Plantain
Sagittaria latifolia	Swamp Potato
Amaryllidaceae	**(Amaryllis Family)**
Hypoxis hirsuta	Yellow Stargrass
Araceae	**(Arum Family)**
Arisaema triphyllum	Jack-in-the-Pulpit
Cyperaceae	**(Sedge Family)**
**Carex aestivalis*	Sedge
Carex amphibola	Sedge
Carex annectens	Sedge
Carex blanda	Sedge
Carex baileyi	Sedge

TABLE I (Continued)

Carex caroliniana	Sedge
Carex comosa	Sedge
Carex crinita	Drooping Sedge
Carex crus-corvi	Sedge
Carex debilis var. *debilis*	Sedge
Carex debilis var. *pubera*	Sedge
Carex frankii	Sedge
**Carex gigantea*	Giant Sedge
Carex gracillima	Sedge
Carex gyranda	Sedge
Carex hirsutella	Sedge
Carex incomperta	Sedge
Carex intumescens	Sedge
**Carex joori*	Sedge
Carex laxiflora	Sedge
**Carex leptonervia*	Sedge
Carex lupulina	Sedge
Carex lurida	Sedge
Carex marginatus	Sedge
Carex mesochorea	Sedge
Carex normalis	Sedge
Carex oligocarpa	Sedge
Carex penduncula ta	Sedge
Carex platyphylla	Sedge
Carex projecta	Sedge
Carex rosea	Sedge
Carex scoparia	Sedge

TABLE I (Continued)

Carex swanii	Sedge
Carex tribuloides	Sedge
Carex typhina	Sedge
Carex virescens	Sedge
Carex vulpinoidea	Sedge
Cyperus strigosus	Nut Sedge
Eleocharis quadrangulata	Spike Rush
Eleocharis tenuis	Kill Cow
Eleocharis verrucosa	Spike Rush
Scirpus atrovirens	Rush
Scirpus cyperinus	Wool Grass
Scirpus lineatus	Rush
Scirpus polyphyllus	Leafy Bulrush
Scirpus rubrotinctus	Bulrush
Scirpus sp.	Rush
Dioscoreaceae	**(Yam Family)**
Dioscorea villosa	Wild Yam
Gramineae	**(Grass Family)**
Agrostis hyemalis	Hairgrass
Arundinaria gigantea	Cane
Bromus latifolia	Bromegrass
Dactylis glomerata	Orchard Grass
Danthonia compressa	Hairgrass
Danthonia spicata	Poverty Grass
Echinochloa crusgalli	Barnyard Grass
Erianthus alopecuroides	Plumegrass
Festuca elatior	Meadow Fescue

TABLE I (Continued)

Glyceria striata	Fowl Mannagrass
Holcus lanatus	Velvet Grass
Hystrix patula	Bottle-brush Grass
Lolium perenne	Perennial Rye Grass
Lolium sp.	Rye Grass
Panicum clandestinum	Deertongue Grass
Panicum microcarpon	Small-fruited Panic Grass
Panicum philadelphicum	Wood Witch Grass
Panicum sp.	Panic Grass
Panicum villosissimum	Panic Grass
Panicum xalapense	Panic Grass
Phalaris arundinaceae	Reed Canary Grass
Phleum pratense	Timothy
Setaria glauca	Yellow Foxtail
Sorghum halepense	Johnson Grass
Uniola latifolia	Uniola
Iridaceae	**(Iris Family)**
Iris cristata	Crested Dwarf Iris
Iris verna	Dwarf Iris
Sisyrinchium angustifolium	Blue-eyed Grass
Juncaceae	**(Rush Family)**
Juncus acuminatus	Rush
Juncus brachycephalus	Rush
Juncus diffusissimus	Rush
Juncus dudleyi	Rush
Juncus effusus	Common Rush
Juncus marginatus	Rush

TABLE I (Continued)

Juncus secundus	Rush
Juncus subcaudatus	Rush
Juncus tenuis	Path Rush
Luzula acuminata	Woodrush
Luzula campestris	Woodrush
Liliaceae	**(Lily Family)**
Allium canadense	Meadow Garlic
Asparagus officinalis	Garden Asparagus
Chamaelirium luteum	Devil's Bit
Clintonia sp.	Clintonia
Erythronium americanum	Trout Lily
Hemerocallis fulva	Common Day Lily
Medeola virginiana	Indian Cucumber Root
Ornithogalum umbellatum	Star of Bethlehem
Polygonatum biflorum	Common Solomon's Seal
Smilacina racemosa	False Solomon's Seal
Smilax glauca	Saw Brier
Smilax herbacea	Greenbrier
Trillium cernuum	Nodding Trillium
Trillium cuneatum	Trillium
Trillium erectum	Wake Robin
Trillium grandiflorum	Large Flowered Trillium
Trillium sessile	Sessile Trillium
Orchidaceae	**(Orchid Family)**
Aplectrum hyemale	Puttyroot
Cypripedium acaule	Pink Lady's Slipper
Goodyera pubescens	Downy Rattlesnake Plantain

TABLE I (Continued)

Habenaria clavellata	Small Green Wood Orchid
Habenaria flava	Pale Green Orchis
Habenaria lacera	Ragged Fringed Orchid
Habenaria psycodes	Small Purple Fringed Orchid
Spiranthes cernua	Nodding Ladies'-Tresses
Spiranthes gracilis	Slender Ladies'-Tresses
Typhaceae	**(Cattail Family)**
Typha latifolia	Common Cattail
Zosteraceae	**(Pondweed Family)**
Potamogeton sp.	Pondweed
Potamogeton spirillus	Pondweed
Angiospermae-Dicotyledoneae	**(Dicots)**
Acanthaceae	**(Acanthus Family)**
Ruellia caroliniensis	Ruellia
Aceraceae	**(Maple Family)**
Acer negundo	Boxelder
Acer rubrum	Red Maple
Acer saccharinum	Silver Maple
Acer saccharum	Sugar Maple
Amaryllidaceae	**(Amaryllis Family)**
Hypoxis hirsuta	Yellow Stargrass
Sisyrinchium mucronatum	Blue-eyed Grass
Anacardiaceae	**(Cashew Family)**
Rhus copallina	Winged Sumac
Rhus glabra	Smooth Sumac
Rhus radicans	Poison Ivy
Rhus vernix	Poison Sumac

TABLE I (Continued)

Annonaceae	**(Custard Apple Family)**
Asimina triloba	Pawpaw
Apocynaceae	**(Dogbane Family)**
Apocynum cannabinum	Indian Hemp
Vinca minor	Periwinkle
Aquifoliaceae	**(Holly Family)**
Ilex opaca	American Holly
Aristolochiaceae	**(Birthwort Family)**
Asarum arifolium	Little Brown Jug
Asarum canadense	Wild Ginger
Asarum sp.	Heartleaf
Asclepiadaceae	**(Milkweed Family)**
Asclepias tuberosa	Butterfly Weed
Asclepias syriaca	Common Milkweed
Asteraceae	**(Composite Family)**
Achillea millefolium	Yarrow
Ambrosia artemisiifolia	Common Ragweed
Ambrosia trifida	Giant Ragweed
Aster acuminatus	Mountain Aster
Aster cordifolius	Heart-leaved Aster
Aster divaricatus	White Wood Aster
Aster laevis	Smooth Aster
Aster lateriflorus	Calico Aster
Aster novae-angliae	New England Aster
Aster patens	Late Purple Aster
Aster pilosus	White Heath Aster
Aster prenanthioides	Crooked-stem Aster
Aster simplex	Panicled Aster

TABLE I (Continued)

Aster umbellatus	Flat-top White Aster
Chrysanthemum leucanthemum	Ox-eye Daisy
Chrysopsis mariana	Maryland Golden Aster
Coreopsis auriculata	Running Tickseed
Coreopsis pubescens	Downy Coreopsis
Eupatorium coelestinum	Mistflower
Eupatorium fistulosum	Common Joe Pye Weed
Eupatorium pubescens	Hairy Thoroughwort
Eupatorium rugosum	White Snakeroot
Eupatorium serotinum	Late-flowering Thoroughwort
Gnaphalium purpureum	Purplish Cudweed
Helenium autumnale	Yellow Sneezeweed
Helianthus decapetalus	Thin-leaved Sunflower
Helianthus giganteus	Giant Sunflower
Helianthus laetiflorus	Showy Sunflower
Helianthus strumosus	Pale-leaved Sunflower
Hieracium spp.(3)	Hawkweed
Krigia biflora	Cynthia
Prenanthes trifoliata	Lion's Foot
Sanicula canadensis	Black Snakeroot
Senecio smallii	Small's Ragwort
Sericocarpus asteroides	Toothed White-topped Aster
Solidago altissima	Tall goldenrod
Solidago bootii	Boott's Goldenrod
Solidago canadensis	Canada Goldenrod
Solidago caesia	Wreath Goldenrod

TABLE I (Continued)

**Solidago curtisii*	Curtis' Goldenrod
Solidago flexicaulis	Broadleaf Goldenrod
Solidago odora	Sweet Goldenrod
Solidago squarrosa	Squarrosa Goldenrod
Solidago rugosa	Wrinkled-leaf Goldenrod
Solidago ulmifolia	Elm-leaf Goldenrod
Taraxacum officinale	Common Dandelion
Tussilago farfara	Coltsfoot
Verbesina alternifolia	Wingstem
Vernonia altissima	Tall Ironweed
Vernonia noveboracensis	New York Ironweed
Balsaminaceae	**(Touch-Me-Not Family)**
Impatiens capensis	Spotted Touch-Me-Not
Impatiens pallida	Pale Touch-Me-Not
Berberidaceae	**(Barberry Family)**
Caulophyllum thalictroides	Blue Cohosh
Podophyllum peltatum	May-Apple
Bignoniaceae	**(Trumpet-Creeper Family)**
Campsis radicans	Trumpet-Creeper
Catalpa sp.	Catalpa
Boraginaceae	**(Borage Family)**
Mertensia virginica	Bluebells
Calycanthaceae	**(Strawberry Shrub Family)**
Calycanthus floridus	Strawberry Bush
Campanulaceae	**(Bluebell Family)**
Campanula divaricata	Southern Bellflower

TABLE I (Continued)

Caprifoliaceae	**(Honeysuckle Family)**
Lonicera japonica	Japanese Honeysuckle
Sambucus canadensis *Viburnum acerifolium*	Common Elderberry Maple-leaf Arrowwood
Viburnum sp.	Viburnum
Lonicera japonica	Japanese Honeysuckle
Caryophyllaceae	**(Pink Family)**
Saponaria officinalis	Bouncing Bet
Silene rotundifolia	Round-leaved Catchfly
Silene virginica	Red Catchfly
Celastraceae	**(Stafftree Family)**
Euonymus americanus	Strawberry Bush
Euonymus atropurpureus	Burning Bush
Clethraceae	**(White Alder Family)**
Clethra acuminata	Sweet Pepperbush
Convolvulaceae	**(Morning-Glory Family)**
Convolvulus sepium	Hedge Bindweed
Ipomoea pandurata	Morning-Glory
Cornaceae	**(Dogwood Family)**
Cornus florida	Flowering Dogwood
Cornus rugosa	Round-leaved Dogwood
Cornus spp.(3)	Dogwood
Corylaceae	**(Hazel Family)**
Alnus serrulata	Smooth Alder
Betula lenta	Sweet Birch
Betula nigra	River Birch
Carpinus caroliniana	American Hornbeam
Corylus americana	Hazelnut

TABLE I (Continued)

Ostrya virginiana	Hop Hornbeam
Cruciferae	**(Mustard Family)**
Alliaria officinalis	Garlic Mustard
Barbarea vulgaris	Winter Cress
Ericaceae	**(Heath Family)**
Azalea calendulacea	Flame Azalea
Epigaea repens	Trailing Arbutus
Gaultheria hispidula?	Snow Berry
Gaultheria procumbens	Mountain Tea
Kalmia latifolia	Mountain Laurel
Menziesia pilosa	Allegheny Menziesia
Oxydendrum arboreum	Sourwood
Rhododendron maximum	Great Laurel
Vaccinium pallidum	Upland Low Blueberry
Vaccinium spp.(2)	Blueberry
Gaylussacia baccata	Black Huckleberry
Euphorbiaceae	**(Spurge Family)**
Euphorbia sp.	Spurge
Fabaceae	**(Legume Family)**
Albizzia julibrissin	Mimosa
**Baptista tinctoria*	Wild Indigo
Cercis canadensis	Redbud
Coronilla varia	Crown Vetch
Desmodium pauciflorum	Stick-Tight
Lespedeza cuneata	Sericea
Robinia pseudo-acacia	Black Locust
Trifolium campestre	Low Hop Clover
Trifolium pratense	Red Clover

TABLE I (Continued)

Trifolium repens	White Clover
Fagaceae	**(Beech Family)**
Betula nigra	River Birch
Castanea dentata	Chestnut
Fagus grandifolia	American Beech
Quercus alba	White Oak
Quercus bicolor	Swamp White Oak
Quercus borealis	Red Oak
Quercus coccinea	Scarlet Oak
Quercus falcata	Southern Red Oak
Quercus imbricaria	Shingle Oak
Quercus macrocarpa	Bur Oak
Quercus marilandica	Blackjack Oak
Quercus montana	Chestnut Oak
Quercus muehlenbergii	Chinquapin Oak
Quercus stellata	Post Oak
Quercus velutina	Black Oak
Gentianaceae	**(Gentian Family)**
Gentiana austro-montana	Southern Mountain Gentian
Gentiana saponaria	Soapwort Gentian
Geranium maculatum	Wild Geranium
Hamamelidaceae	**(Witch-Hazel Family)**
Hamamelis virginiana	Witch Hazel
Liquidambar styraciflua	Sweet Gum
Hippocastanaceae	**(Buckeye Family)**
Aesculus glabra	Ohio Buckeye
Hydrophyllaceae	**(Waterleaf Family)**

TABLE I (Continued)

Hydrophyllum appendiculatum	Appendaged Waterleaf
Phacelia sp.	Phacelia
Hypericaceae	**(St. John's Wort Family)**
Hypericum perforatum	Common St. John's Wort
Juglandaceae	**(Walnut Family)**
Carya cordiformis	Bitternut Hickory
Carya glabra	Pignut Hickory
Carya ovata	Shagbark Hickory
Carya tomentosa	Mockernut Hickory
Juglans nigra	Black Walnut
Labiatae	**(Mint Family)**
Cunila origanoides	Dittany
Monarda didyma	Bee Balm
Monarda fistulosa	Wild Bergamot
Prunella vulgaris	Heal-All
Pycnanthemum incanum	Hoary Mountain Mint
Salvia lyrata	Wild Sage
Scutellaria integrifolia	Large-flowered Skullcap
Lauraceae	**(Laurel Family)**
Lindera benzoin	Spicebush
Sassafras albidum	Sassafras
Linaceae	**(Flax Family)**
Linum virginianum	Virginia Yellow Flax
Lobeliaceae	**(Lobelia Family)**
Lobelia inflata	Indian Tobacco
Lobelia siphilitica	Great Blue Lobelia
Lobelia puberula	Downy Lobelia

TABLE I (Continued)

Loganiaceae	**(Logania Family)**
Spigelia marilandica	Indian Pink
Magnoliaceae	**(Magnolia Family)**
Liriodendron tulipifera	Tulip Poplar
Magnolia acuminata	Cucumber Magnolia
Magnolia fraseri	Mountain Magnolia
Magnolia macrophylla	Large-leaf Magnolia
Magnolia tripetala	Umbrella Magnolia
Menispermaceae	**(Moonseed Family)**
Menispermum canadensis	Canada Moonseed
Moraceae	**(Mulberry Family)**
Broussonetia papyrifera	Paper Mulberry
Morus alba	White Mulberry
Morus rubra	Red Mulberry
Nymphaeaceae	**(Waterlily Family)**
Brasenia schreberi	Watershield
Nyssaceae	**(Black Gum Family)**
Nyssa sylvatica	Black Gum
Oleaceae	**(Olive Family)**
Fraxinus americana	White Ash
Ligustrum vulgare	Privet
Onagraceae	**(Evening Primrose Family)**
Ludwigia alternifolia	Seedbox
Oenothera biennis	Evening Primrose
Orobanchaceae	**(Broomrape Family)**
Epifagus virginiana	Beechdrops
Oxalidaceae	**(Wood Sorrel Family)**
Oxalis europaea	European Yellow Wood Sorrel

TABLE I (Continued)

Oxalis stricta	Upright Yellow Wood Sorrel
Papaveraceae	**(Poppy Family)**
Sanguinaria canadensis	Bloodroot
Phytolaccaceae	**(Pokeweed Family)**
Phytolacca americana	Pokeweed
Plantaginaceae	**(Plantain Family)**
Plantago aristata	Bracted Plantain
Plantago lanceolata	English Plantain
Plantago rugelii	Pale Plantain
Platanaceae	**(Planetree Family)**
Platanus occidentalis	Sycamore
Polygonaceae	**(Buckwheat Family)**
Polygonum hydropiper	Common Smartweed
Polygonum sp.	Water Pepper
Rumex acetosella	Field Sorrel
Primulaceae	**(Primrose Family)**
Lysimachia lanceolata	Lance-leaved Loosestrife
Lysimachia quadrifolia	Whorled Loosestrife
Portulacaceae	**(Purslane Family)**
Claytonia virginica	Spring Beauty
Pyrolaceae	**(Wintergreen Family)**
Chimaphila maculata	Spotted Wintergreen
Ranunculaceae	**(Crowfoot Family)**
Anemone quinquefolia	Wood Anemone
Anemone virginiana	Thimbleweed
Chelone glabra	Turtlehead

TABLE I (Continued)

Clematis viorna	Leatherflower
Hepatica americana	Roundlobe Hepatica
Thalictrum clavatum	Mountain Meadowrue
Ranunculus acris	Meadow Buttercup
Ranunculus bulbosa	Bulbous Buttercup
Ranunculus hispidus	Hispid Buttercup
Thalictrum polygamum	Tall Meadowrue
Rhamnaceae	**(Buckthorn Family)**
Rhamnus caroliniana	Carolina Buckthorn
Rosaceae	**(Rose Family)**
Amelanchier arborea	Serviceberry
Crataegus spp.(3)	Hawthorn
Geum virginianum	Virginia Avens
Gillenia trifoliata	Indian Psysic
Prunus serotina	Wild Cherry
Ribes missouriense	Missouri Gooseberry
Rosa multiflora	Multifloral Rose
Rubus spp.(3)	Blackberry
Rubus sp.	Dewberry
Rubus occidentalis	Raspberry
Spirea tomentosa	Hardtack
Rubiaceae	**(Madder Family)**
Cephalanthus occidentalis	Buttonbush
Diodia teres	Rough Buttonweed
Diodia virginiana	Larger Buttonweed
Galium triflorum	Sweet-scented Bedstraw
Houstonia caerulea	Bluets
Houstonia purpurea	Large Summer Bluets

TABLE I (Continued)

Salicaceae	**(Willow Family)**
Populus deltoides	Cottonwood
Populus grandidentata	Bigtooth Aspen
Salix nigra	Black Willow
Santalaceae	**(Sandlewood Family)**
Pyrularia pubera	Buffalonut
Saxifragaceae	**(Saxifrage Family)**
Heuchera americana	Alumroot
Heuchera parviflora	Small-flowered Heuchera
Hydrangea arborescens	Wild Hydrangea
**Parnassia asarifolia*	Kidneyleaf Grass of Parnassus
Ribes sp.	Gooseberry
Scrophulariaceae	**(Figwort Family)**
Chelone glabra	Turtlehead
Clematis viorna	Leatherflower
Mimulus moschatus	Muskflower
Pedicularis canadensis	Common Lousewort
Penstemon laevigatus	Smooth Beardtongue
Verbascum blattaria	Moth Mullein
Verbascum thapsus	Great Mullein
Veronica officinalis	Speedwell
Veronica sp.	Speedwell
Simaroubaceae	**(Tree-of-Heaven Family)**
Ailanthus altissima	Tree-of-Heaven
Solanaceae	**(Nightshade Family)**
Solanum americanum	Black Nightshade
Solanum carolinense	Horse-nettle
Thymelaeaceae	**(Mezereum Family)**

TABLE I (Continued)

Eleagnus umbellata	Autumn Olive
Tiliaceae	**(Basswood Family)**
Tilia americana	Basswood
Ulmaceae	**(Elm Family)**
Ulmus alata	Winged Elm
Ulmus rubra	Slippery Elm
Urticaceae	**(Nettle Family)**
Laportea canadensis	Wood Nettle
Urtica dioica	Stinging Nettle
Valerianaceae	**(Valerian Family)**
Valerianella chenopodifolia	Goose-foot Corn Salad
Violaceae	**(Violet Family)**
Viola blanda	Sweet White Violet
Viola papilionacea	Common Blue Violet
Viola rostrata	Long-spurred Violet
Viola striata	Striped Violet
Vitaceae	**(Vine Family)**
Parthenocissus quinquefolia	Virginia Creeper
Vitis aestivalis	Summer Grape
Vitis vulpina	Winter Grape

*Denotes species rare in the area.

8. Vertebrate Fauna in Terrestrial Habitats

The terrestrial vertebrate fauna in the project impact area has been studied to a limited degree. Stephens (1985) studied the herpetofauna of McCreary County, and Mengel (1965) listed accounts of bird life in McCreary and Whitley Counties. The USFS Cooperative Inventory of the Stearns Ranger District (1990) identified rare bats that occur in the vicinity, including the Indiana bat (*Myotis sodalis*), small-footed bat (*Myotis leibii*), northern long-eared bat (*Myotis septentrionalis*), and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*). The *Inventory* indicated that a mixture of northern and southern species occur. For instance, the smokey shrew (*Sorex fumeus*), usually a more northern species was found in the same areas as the Allegheny woodrat (*Neotoma magister*), a species of southern locales. Likewise, the red-eyed vireo (*Vireo olivaceus*), a temperate forest species occured with the black-throated green warbler (*Dendroica virens*), a northern species. In addition to common species, several other unusual and rare species are known from the project area. Meade (1992) documented the pygmy shrew (*Sorex hoyi winnemana*) as occurring in McCreary County, the southeastern shrew (*Sorex longirostris*) in Whitley County, and the woodland jumping mouse (*Napaeozapus insignis*) and the spotted skunk (*Spilogale putorius*) in McCreary County. There are periodic reports of cougar and black bear sightings from some of the more remote areas in the project corridor. The USFS (1987) documented a black bear occurrence on Bon Jellico Mountain. There is a record of the red-cockaded woodpecker from the Pleasant Run area on the Hollyhill USGS quadrangle (USFS, 1987). No red-cockaded woodpeckers were identified during this study, but new drilling sites on trees near the project have been observed. Various shrews were identified from pitfall traps set for this study, including the smoky shrew, and the short-tailed shrew. The prairie deer mouse and the white-footed mouse were taken in pitfall traps in several areas along the project corridor. The beaver is found in the Pleasant Run drainage, and whitetail deer occur throughout the project area. Avian species were also plentiful.

Certainly more species exist in the study area than those reported above and those I identified. Terrestrial vertebrate species identified during this study are listed in TABLE II.

TABLE II. Terrestrial Vertebrate Species Identified during Field Investigations along the KY 92 Improvement Project Corridor.

Scientific Name	Common Name
Mammalia	(Mammals)
Didelphis virginiana	Virginia Opossum
Sorex fumeus	Smoky Shrew
Blarina brevicauda	Short-tailed Shrew
Peromyscus leucopus	White-footed Mouse
Peromyscus maniculatus bairdii	Prairie Deer Mouse
Neotoma magister	Alleghany Woodrat
Microtus ochrogaster	Prairie Vole
**Ursus americanus*	Black Bear
Procyon lotor	Raccoon
Mephitis mephitis	Striped Skunk
Canis latrans	Coyote
Felis concolor	Cougar
Lynx rufus	Bobcat
Castor canadensis	Beaver
Ondatra zibethicus	Muskrat
Odocoileus virginianus	Whitetail Deer
Aves	(Birds)
Ardea herodias	Great Blue Heron
Butorides striatus	Green-backed Heron
Branta canadensis	Canada Goose
Coragyps atratus	Black Vulture
Buteo jamaicensis	Red-tailed Hawk
Buteo platypterus	Broad-winged Hawk

TABLE II (Continued)

Buteo lineatus	Red-shouldered Hawk
Falco sparverius	American Kestrel
Bobasa umbellus	Ruffed Grouse
Meleagris gallopavo	Wild Turkey
Colinus virginianus	Northern Bobwhite
Charadrius vociferus	Killdeer
Zenaida macroura	Mourning Dove
Coccyzus americanus	Yellow-billed Cuckoo
Otus asio	Eastern Screech-owl
Bubo virginianus	Great Horned Owl
Chordeiles minor	Common Nighthawk
Caprimulgus carolinensis	Chuck-will's-widow
Archilochus colubris	Ruby-throated Hummingbird
Ceryle alcyon	Belted Kingfisher
Dryocopus pileatus	Pileated Woodpecker
Colaptes auratus	Northern Flicker
Melanerpes carolinus	Red-bellied Woodpecker
Picoides villosus	Hairy Woodpecker
Picoides pubescens	Downy Woodpecker
Sayornis phoebe	Eastern Phoebe
Tachycineta bicolor	Tree Swallow
Cyanocitta cristata	Bluejay
Corvus brachyrhynchos	Common Crow
Parus carolinensis	Carolina Chickadee
Sitta carolinensis	White-breasted Nuthatch
Thryothorus ludovicianus	Carolina Wren
Regulus sp.	Kinglet

TABLE II (Continued)

Sialia sialis	Eastern Bluebird
Hylocichla mustelina	Wood Thrush
Turdus migratorius	American Robin
Mimus polyglottos	Northern Mockingbird
Toxostoma rufum	Brown Thrasher
Sturnus vulgaris	European Starling
Vireo spp. (2)	Vireo
Seiurus motacilla	Louisiana Waterthrush
Cardinalis cardinalis	Northern Cardinal
Passerina cyanea	Indigo Bunting
Pipilo erythropthalmus	Rufous-sided Towhee
Spizella pusilla	Field Sparrow
Meolspiza melodia	Song Sparrow
Zonotrichia albicollis	White-throated Sparrow
Junco hyemalis	Dark-eyed Junco
Agelaius phoeniceus	Red-winged Blackbird
Sturnella magna	Eastern Meadowlark
Quiscalus quiscula	Common Purple Grackle
Carduelis pinus	Pine Siskin
Carduelis tristis	American Goldfinch
Amphibia/Reptilia	**(Herpetofauna)**
Desmognathus f. fuscus	Northern Dusky Salamander
Notopthalmus v. veridescens	Red-spotted Newt, Red-eft stage
Hemidactylum scutatum	Four-toed Salamander
Scaphiopus h. holbrookii	Eastern Spadefoot Toad
Bufo americanus	American Toad

TABLE II (Continued)

Rana catesbeiana	Bullfrog
Rana clamitans melanota	Green Frog
Rana sylvatica	Wood Frog
Chelydra serpentina	Snapping Turtle
Terrapene c. carolina	Box turtle
**Ophisaurus attenuatus*	Eastern Slender Glass Lizard
Nerodia s. sipedon	Northern Water Snake
Carphophis a. amoenus	Worm Snake
Storeria dekayi	Brown Snake
Elaphe o. obsoleta	Black Rat Snake
**Agkistrodon contortrix mokasen*	Northern Copperhead
Crotalus horridus	Timber Rattlesnake

*Reported by local residents

B. Aquatic Habitats

Aquatic habitats in the proposed project impact area include a number of streams. Beginning at Pine Knot, and following the project east to Williamsburg, streams that may experience adverse impacts with project construction include the headwaters of Cal Creek, main Cal Creek, Perkins Creek, Marsh Creek, Osborn Creek, Pleasant Run Creek, Jellico Creek, Roberts Branch, Paint Creek, Mt. Morgan Hollow, Staniford Hollow and Brier Creek. Other lesser hollows and tributaries may receive some sedimentation.

To help determine water quality, I determined the water chemistry, and sampled the aquatic vertebrates and macroinvertebrate populations, all critical to determining the ecological condition of the streams sampled. In addition, all area wetlands subject to adverse impacts were delineated and impacts were considered.

1. <u>Water Quality</u>

Kentucky's Division of Water Administrative Regulations (1994) listed protection standards for productive warmwater aquatic communities, particularly with respect to fowl and wildlife enhancement, tree growth, and agricultural and industrial uses as follows:

a. Natural alkalinity as $CaCO_3$ shall not be reduced by more than twenty-five percent. Where natural alkalinity is below twenty mg/l $CaCO_3$, no reduction below the natural level is allowed. Alkalinity shall not be reduced or increased to a degree that may adversely affect the aquatic community.
b. pH shall not be less than six nor more than nine and shall not fluctuate more than one (1) unit over a period of twenty-four (24) hours.
c. Flow shall not be altered to a degree which will adversely affect the aquatic community.
d. Temperature shall not exceed thirty-one and seven-tenths degrees Celsius [eighty-nine (89) degrees Fahrenheit].
e. Dissolved oxygen shall be maintained at a minimum concentration of five mg/l daily average; at no time shall the instantaneous minimum be less than four mg/l.
f. Solids

f1. Total dissolved solids shall not be changed to the extent that the indigenous aquatic community is adversely affected.

f2. Total suspended solids shall not be changed to the extent that the indigenous aquatic community is adversely affected.

f3. The addition of settleable solids that may adversely alter the stream bottom is prohibited.

g. Ammonia. The concentration of the un-ionized form shall not be greater than 0.05 mg/l at any time instream after mixing. Un-ionized ammonia shall be determined from values for total ammonia-N (in mg/l), pH and temperature.

All of the criteria adopted for the protection of warm water aquatic life apply to the protection of cold water habitats, with the addition that the minimum concentration of dissolved oxygen shall be kept to six mg/l as a daily average at all times and water temperature shall not be increased above the natural seasonal temperatures through man's activities.

Because some of the parameter paradigms, particularly toxins, are not covered by Kentucky's Warm Water Aquatic Habitat guidelines, upper limits for some Domestic Water Supply criteria, listed below, were followed:

Chloride	250 mg/l
Color	75 Platinum Cobalt Color
Nitrate (NO_3-N)	10 mg/l
Sulfate	250 mg/l
Total Dissolved Solids	750 mg/l

Waters classified as Outstanding Resource Waters (ORW's) necessitate protection. These ORW's include waters designated under the Kentucky Wild Rivers Act (KRS 146.200-146.360); waters designated under the Federal Wild and Scenic River Act (16 U.S.C. 1271 et seq.) as high quality waters constituting an outstanding national resource water; waters identified under the Kentucky Nature Preserves Act (KRS 146.410-146.530), contained within a formally dedicated nature preserve or whose location is published in the registry of natural areas, and waters that support federally-recognized endangered or threatened species under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

Marsh Creek is an ORW, and is listed as a High Quality (HQ) Stream, meaning its quality exceeds that necessary to support water recreation and propagation of fish, shellfish, and wildlife. Marsh Creek is a US DOI potential "Wild and Scenic River" and it also has municipal water intakes. All discharge into Marsh Creek then, must meet non-degradation policy requirements. Jellico Creek is listed by KDFWR as an HQ Fishing Stream. Both Marsh Creek and Jellico Creek have potential spawning areas that may be regionally important in this drainage. Mussel species are known in these streams and "Concentrated Shellfish Areas" may exist. Cal Creek has been listed by the KDNREP as a monitored Natural Area, necessitating a degree of protection.

To some degree, most streams in the project area have been impacted by coal mining. Cal Creek is an exception. Some of the streams (i.e., Jellico Creek, Paint Creek) are beginning to recover from the impact of mining several years ago. The 1996 Kentucky Report to Congress on Water Quality listed portions of Marsh Creek (from milepoint 18.7 to 24.0) as impaired due to siltation from resource extraction and agricultural practices. Other portions, as previously mentioned, are eligible for Wild and Scenic River Status.

Cal Creek was sampled for water quality near its junction with Marsh Creek. In this area, Cal Creek has deeply cut banks lined with weeds and mature trees and shrubs on both sides. Sycamore, paper birch, umbrella magnolia, maples, sourwood and wild cherry were common trees, while hazelnut, spicebush, strawberry bush, and dogwood were common shrubs. Stream width averaged 10ft and the depth of the pool was only 8 to 10in maximum. Measured discharge was $2.9ft^3/s$. The substrate was silty/gravelly. Cal Creek was also sampled in headwater areas (Kidd Cemetery Road and Wild Bill Stephens Road) where it will be impacted if Alternate D is used. Headwater sites were canopied with hemlock-rhododendron plant communities. Substrate in these areas was bedrock or pebbly, gradating to silty.

Perkins Creek was sampled at the junction of KY 1470 and KY 592. The creek has a canopy of trees and shrubs, including sycamores, willows, and bush honeysuckle. The substrate is sandy sediments, with marshy banks. Stream width averages 15ft, and depth is from 0 to 10in. Measured discharge was $6.7ft^3/s$. One interesting item on KY 592 has its own package treatment plant which discharges into the headwaters of the creek. During one visit to that site, it appeared that the package plant was not working, and the wastewater from the funeral home was entering Perkins Creek headwaters apparently untreated.

Marsh Creek is a sluggish stream through the project area. Substrate was sediments, and average width was 20ft. Canopy trees covered the stream except at the KY 92 bridge crossing, and wetlands occurred in many areas of the floodplain. All chemical parameters tested in Marsh Creek were within normal ranges. The dissolved oxygen was somewhat lower than other area streams and orthophosphate was slightly elevated above area norms (See Figure 10).

Figure 10. Marsh Creek

Osborn Creek was sampled near KY 1470, near its confluence with Marsh Creek. There the canopy is relatively open with smaller willows and river birch dominating; alder lines the stream. The substrate was composed of sediments. Stream width averaged 15ft (4.75m), and depth ranged from 18in (.457m) to 4ft (1.22m). Nitrate nitrogen was somewhat higher in Osborn Creek than most other streams sampled, except for Pleasant Run. Cattle have direct access to Osborn Creek upstream of the sample site.

Pleasant Run is a stream under stress from mining in the area, agricultural impacts, and from recent construction within a portion of the surrounding wetlands. The Kentucky Report to Congress on Water Quality (1996) lists the sources of impairment for Pleasant Run from milepoint 2.0 to 2.7 is an impaired stream due to hydromodification and agricultural practices. Field investigations conducted for this study showed Pleasant Run as a biologically dead stream. Personal communication with Doug Stephens, Southeast District Fisheries Biologist with Kentucky's Department of Fish and Wildlife Resources concurred with our observations. The floodplain wetlands along Pleasant Run just upstream of the KY 92 bridge crossing have been drained with all vegetation removed. At the bridge, there is an alder/river birch canopy and two beaver lodges. At some time during my field investigations, a local boy killed the beavers that had built the lodges. Downstream, the creek had been dammed in several places for use as settling ponds for the mining. The pH was 6.2 at the sample time, and conductivity was high at 630. The substrate was rocks and sediments. At the KY 92 bridge crossing, Pleasant Run is about 20ft wide and several feet deep, being very marshy and slow moving there. Discharge was not measured (See Figure 11).

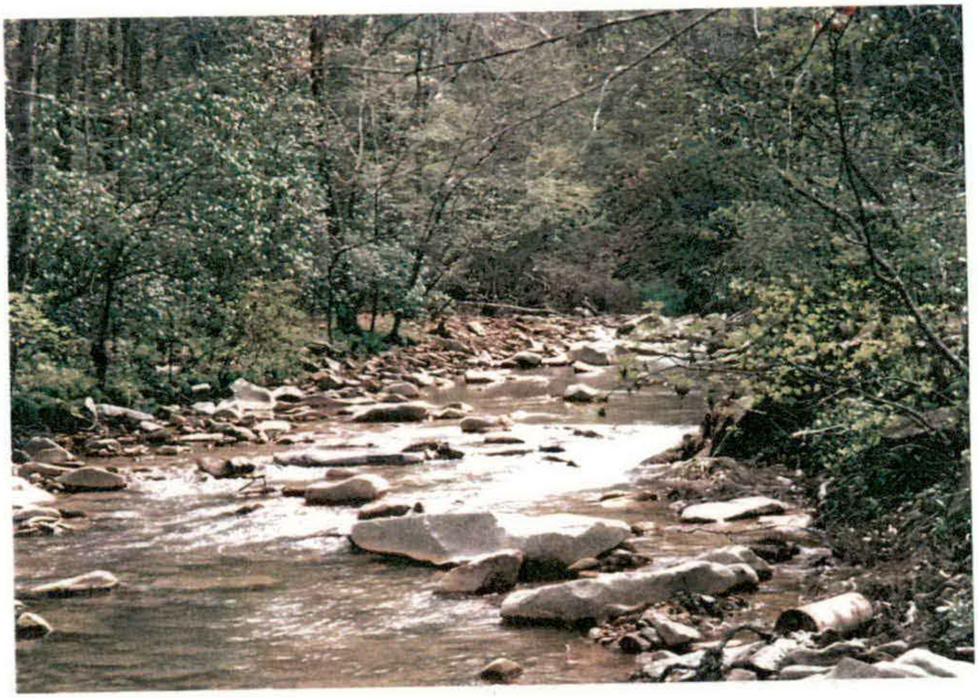


Figure 11. Pleasant Run

Jellico Creek was sampled near the KY 92 bridge. This area had both shallow riffles and deeper pools. One side of the stream was a sheer cliff-face with scattered trees; the other side was floodplain, with abundant canopy. The main trees in this area were river birch and hemlock, with alder being the dominant shrub. Stream width averaged 50ft, and depth was generally 10 to 18in. Measured discharge was $508ft^3/s$. Local people told me that several years ago, no fish could be caught from Jellico Creek, but now people are enjoying fishing again (See Figure 12).

Figure 12. Jellico Creek

Paint Creek was sampled at a waterfall pool near existing KY 92. This area was canopied with maples, hemlock, rhododendron, paper birch, magnolias, catalpas, mountain laurel, and wild hydrangeas. Substrate was generally bedrock or boulders. Stream width averaged 15ft and the pool's depth ranged from 6 to 18in. The depth below the falls was less than 12in, as the stream quickly dropped in elevation and became a fast, boulder-strewn mountain stream. It appears that the stream has not completely recovered from past mining activity. Measured discharge was 3.2ft^3/s (See Figure 13).

Figure 13. Paint Creek at Falls

Roberts Branch, a tributary of Paint Creek, apparently impacts Paint Creek to a degree because I also did a comparison of Paint Creek above its junction with Roberts Branch, and below the junction. Roberts Branch showed a low pH of 3, probably a result of the mining operation in its headwaters. However, a later sample showed the pH to be 8. The fluctuating pH was probably a result of mine pond treatment in the headwaters of Robert's Branch. The substrate was silty/gravelly, and cattle had direct access to the stream. The canopy was sycamore, black birch, ironwood, and dogwood. Stream width averaged 12ft; its depth ranged from 0-8 in. Measured discharge was $1.3ft^3/s$.

Mt. Morgan Hollow was sampled 22 April 1997, after it was determined that an alternate may impact that area. The stream is a small, fast-flowing tributary of Brier Creek. The substrate was pebbly/silty. TDS and conductivity were somewhat elevated above area norms. Measured discharge was $3ft^3/s$.

One area of special interest (Campbell, et al. 1990) is the Staniford Hollow area in Whitley County. This area is designated a "Significant Area" (SA) by the USFS because of its population of Yellow-wood (*Cladrastis kentukea*). The road improvement project will cross the mouth of Staniford Hollow and will create some impacts to the SA. For that reason, especially, I sampled the water quality of the stream. Nitrogen ammonia was somewhat elevated, and sulfate was higher than most other streams sampled. The conductivity measured 460. Several mine silt ponds occur upstream of the sample site in Staniford Hollow, but mining stopped several years ago. No houses occur in Staniford Hollow.

Brier Creek is a stream obviously impacted from several sources. The headwater area has been recently strip-mined, and some houses downstream have apparent sewer lines emptying directly into the stream. Farther downstream, agricultural runoff and road pollutants are sources of contamination as well. The pH of Brier Creek was 6.9, generally a little lower than the other streams sampled, while conductivity was 410, higher than most other streams sampled, except Staniford Hollow and Pleasant Run. Ammonia nitrogen was also higher than any of the other streams sampled. Measured discharge in the headwater area was $2.8 ft^3/s$.

TABLE III lists streams sampled during this study, including water parameter method numbers as found in the HACH DREL/2000 Spectrophotometer handbook. To simplify overall results, only the first sample includes measurement standards; all other samples have the same standards.

TABLE III. Water Quality Analyses of KY 92 Improvement Project Area Streams.

Parameter	Results
1. Cal Creek near Marsh Creek, 9 October 1995	
Color	38 PtCo(Platinum Cobalt Color Units)
Turbidity	8FTU (Formazine Turbidity Units)
pH	7.9
Nitrate Nitrogen	0.02 mg/L NNo_3-H
Alkalinity	11.8 mg/L, $CaCo_3$ total
Acidity	47.4 mg/L, $CaCo_3$ phenolphthalein
Chloride	15.6 mg/L
Ammonia Nitrogen	0.02 mg/L NNH_3-N
Sulfate	10 mg/L SO_4^{2-}
Hardness	35.5 mg/L, $CaCo_3$ total
TDS	2.4 mg/L
Orthophosphate	0.01 mg/L PO_4^{3-}
Dissolved Oxygen	7.4 mg/L
Temperature	17.0 C°
Conductivity	80µS/cm
Discharge	3.7ft^3/s
2 Cal Creek, Wild Bill Stephens Road, 9 October 1995	
Color	45
Turbidity	23
pH	6.9
Nitrate Nitrogen	0.40
Alkalinity	23
Acidity	45
Chloride	89
Ammonia Nitrogen	0.19
Sulfate	3
Hardness	22.8
TDS	32
Orthophosphate	0.05
Dissolved Oxygen	10.4
Temperature	17.0
Conductivity	140
Discharge	3.7
3. Cal Creek, Kidd Cemetery Road, 9 October 1995	
Color	0
Turbidity	1

TABLE III (Continued)

pH	6.9
Nitrate Nitrogen	0.10
Alkalinity	12
Acidity	66
Chloride	81.0
Ammonia Nitrogen	0
Sulfate	0
Hardness	12.0
TDS	10
Orthophosphates	0.77
Dissolved Oxygen	10.9
Temperature	16.9
Conductivity	78
Discharge	3.0

4. **Perkins Creek near Marsh Creek 9 October 1995**

Color	0
Turbidity	4
pH	7.6
Nitrate Nitrogen	0.02
Alkalinity	9.3
Acidity	46.5
Chloride	30.8
Ammonia Nitrogen	0.01
Sulfate	7
Hardness	39.3
TDS	31
Orthophosphate	0.03
Dissolved Oxygen	7.0
Temperature	16.0
Conductivity	126
Discharge	6.0

5. **Marsh Creek at KY 92 Bridge, 29 November 1995**

Color	26
Turbidity	3
pH	7.1
Nitrate Nitrogen	0.10
Alkalinity	17.4
Acidity	32.9
Chloride	14.2
Ammonia Nitrogen	0.07
Sulfate	75

TABLE III (Continued)

Hardness	40.6
TDS	27
Orthophosphate	0.20
Dissolved Oxygen	8.3
Temperature	1.1
Conductivity	190
Discharge	9.4

6. Osborn Creek near Marsh Creek, 29 November 1995

Color	18
Turbidity	4
PH	7.1
Nitrate Nitrogen	0.20
Alkalinity	15.2
Acidity	33.2
Chloride	10
Ammonia Nitrogen	0.04
Sulfate	11
Hardness	21.1
TDS	34
Orthophosphate	0.11
Dissolved Oxygen	11.8
Temperature	1.6
Conductivity	386
Discharge	--

7. Headwaters of Pleasant Run, 29 November 1995

Color	2
Turbidity	0
pH	6.2
Nitrate Nitrogen	0.3
Alkalinity	0
Acidity	56.4
Chloride	6.6
Ammonia Nitrogen	0.11
Sulfate	71
Hardness	119
TDS	18
Dissolved Oxygen	12.6
Temperature	1.0
Conductivity	630
Discharge	--

TABLE III (Continued)

8. Jellico Creek, 29 November 1995

Color	47
Turbidity	2
pH	7.6
Nitrate Nitrogen	0.2
Alkalinity	27.5
Acidity	17.5
Chloride	51.2
Ammonia Nitrogen	0.08
Sulfate	13
Hardness	23.7
TDS	27
Orthophosphate	0.09
Dissolved Oxygen	8.7
Temperature	1.9
Conductivity	128
Discharge	50.8

9. Paint Creek, 10 October 1995

Color	5
Turbidity	2
pH	8.0
Nitrate Nitrogen	0.1
Alkalinity	40
Acidity	10.1
Chloride	18.8
Ammonia Nitrogen	0.09
Sulfate	41
Hardness	45.5
TDS	14
Orthophosphate	0.03
Dissolved Oxygen	12.8
Temperature	1.9
Conductivity	98
Discharge	3.2

10. Roberts Branch, 29 November 1995

Color	9
Turbidity	7
pH	8.1
Nitrate Nitrogen	0.0
Acidity	5.3
Chloride	11.2

TABLE III (Continued)

Ammonia Nitrogen	0.10
Sulfate	34
Hardness	26.9
TDS	16
Orthophosphate	0.65
Dissolved Oxygen	8.0
Temperature	0.9
Conductivity	450
Discharge	1.3

11. Mt. Morgan Hollow, 22 April 1997

Color	18
Turbidity	7
pH	7.9
Nitrate Nitrogen	0.0
Alkalinity	10.1
Acidity	11.0
Chloride	8.0
Ammonia Nitrogen	0.09
Sulfate	35
Hardness	9.2
TDS	55
Orthophosphate	0.01
Dissolved Oxygen	11.6
Temperature	18.0
Conductivity	60
Discharge	1.0

12. Staniford Hollow, 26 March 1998

Color	7
Turbidity	13
pH	7.5
Nitrate Nitrogen	0.8
Alkalinity	7.2
Acidity	16
Chloride	9.0
Ammonia Nitrogen	0.2
Sulfate	75
Hardness	13.5
TDS	22
Orthophosphate	0.21
Dissolved Oxygen	14.3

TABLE III (Continued)

Temperature	13.0
Conductivity	460
Discharge	3.0

13. Brier Creek, 29 November 1995

Color	6
Turbidity	5
pH	6.9
Nitrate Nitrogen	0.0
Alkalinity	36.9
Acidity	6.7
Chloride	4.9
Ammonia Nitrogen	0.27
Sulfate	39.0
Hardness	33.8
TDS	50
Orthophosphate	0.02
Dissolved Oxygen	12.4
Temperature	0.8
Conductivity	410
Discharge	2.8

TABLE IV. Stream Parameter Summary, KY 92 Project, Whitley and McCreary Counties.

	Station Numbers												
Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13
Color	38	45	0	0	26	18	2	47	5	9	18	7	6
Turbidity	8	23	1	4	3	4	0	2	2	7	7	13	5
PH	7.9	6.9	6.9	7.6	7.1	7.1	6.2	7.6	8.0	8.1	7.9	7.5	6.9
Nitrate Nitrogen	0.02	0.40	0.10	0.02	0.10	0.20	0.30	0.20	0.10	0.00	0.00	0.80	0.00
Alkalinity	11.8	23.0	12.0	9.3	17.4	15.2	0.0	27.5	40.0	6.2	10.1	7.2	36.9
Acidity	47.4	45.0	66.0	46.5	32.9	33.2	56.4	17.5	10.1	5.3	11.0	16.0	6.7
Chloride	15.6	89.0	81.0	30.8	14.2	10.0	6.6	51.2	18.8	12.2	8.0	9.0	4.9
Ammonia Nitrogen	0.02	0.19	0	0.01	0.07	0.04	0.11	0.08	0.09	0.10	0.09	0.2	0.27
Sulfate	10	3	0	7	75	11	71	13	41	34	35	75	39
Hardness	35.5	22.8	12.0	39.3	40.6	21.1	11.9	23.7	45.5	26.9	9.2	13.5	33.8
TDS	2	32	10	31	27	34	18	27	14	16	55	22	50
Orthophosphate	0.01	0.05	0.77	0.03	0.20	0.11	0.00	0.09	0.03	0.65	0.01	0.21	0.02
Dissolved Oxygen	7.4	10.4	10.9	7.0	8.3	11.8	12.6	8.7	12.8	8.0	11.6	14.3	12.4
Temperature	17.0	17.0	16.9	16.0	1.1	1.6	0.6	1.9	1.9	0.9	18.0	13.0	0.8
Conductivity	80	140	78	126	190	386	630	128	98	450	60	460	410
Discharge	3.7	3.7	3.0	6.0	9.4	–	–	50.8	3.2	1.3	1.0	3.0	2.8

2. Aquatic Vertebrates

Jordan and Swain (1883), the first to report on the vertebrate fauna of McCreary and Whitley counties, listed seven fish, *Poecilichthys sagitta* (=*Etheostoma sagitta*), *E. flabellare* var. *cumberlandicum* (=*E. flabellare*) and *E. susanae* (= *E. nigrum susanae*), from Brier Creek in the project impact area; *Lepomis macrochirus*, *Rhinicthys atronasus* (=*Rhinichthys atratulus*), *Notropis hererodon*, and *Ameiurus natalis* (=*Ictalurus natalis*), from the region. Garman (1894) listed these same fish and added a salamander, *Ambystoma punctatum* (=*A. maculatum*) from McCreary County. Clay (1975) and Burr and Warren (1986) surveyed Kentucky's entire fish fauna, and included numerous records from the study area, while Page and Burr (1991) provided species descriptions and range maps.

Starnes and Starnes (1979) discussed the rarity of the Cumberland johnny darter (*Etheostoma nigrum susanae*) in the upper Cumberland drainage. In 1978, they also described and studied the rare Cumberland blackside dace (*Phoxinus cumberlandensis*) from McCreary and Whitley Counties. O'Bara (1985) surveyed it in the Jellico Creek drainage area, and found that Bucks Branch, just south of the KY 92 project impact area, held the strongest population of this rare dace.

The Cumberland blackside dace is known to occur in several streams in the general area, including Ryans Creek, not impacted by this project's construction, and the mouth of Brier Creek, which will be completely altered. No specimens were identified during our field investigations. The Cumberland blackside dace is endemic to the upper Cumberland River system. It is confined to small upland streams in sluggish pools, with substrates of bedrock, gravel, or sand, and often associated with undercut banks, brush, or rocks. Host streams are shaded and cool, as in the headwater area of Cal Creek (with its overhanging hemlock-rhododendron plant community). The state-listed Cumberland johnny darter was identified from Cal Creek and Marsh Creek. According to Burr and Warren (1986), the johnny darter is found in streams with substrates of sand, silt, or sand-laden bedrock. It is usually in headwater streams in slow-to-moderate gradient areas (See Figure 14).

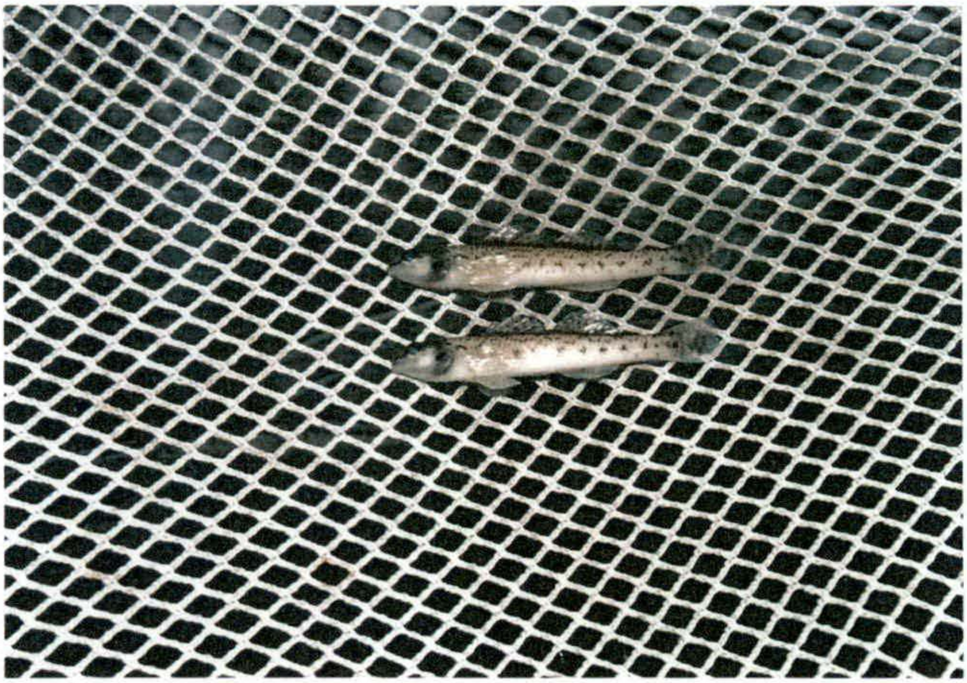


Figure 14. Cumberland Johnny Darter
(*Etheostoma nigrum susanae*)

The arrow darter is restricted to upland Cumberland Mountains and Cumberland Plateau streams. It is also usually found in headwater streams, preferring sluggish pools and areas above and below riffles. It prefers bedrock, cobble, and pebble substrates. The arrow darter was found in Cal Creek, (See Figure 15).

Figure 15. Arrow Darter
(*Etheostoma sagitta*)

All streams sampled showed a good diversity of species, with most species common to the area represented. Most streams also had substantial darter populations, valuable ecological indicators of water quality. Darters generally inhabit streams with riffles and do not tolerate excessive sedimentation. Darters were not identified from Paint Creek and Osborn Creek. Table V lists collected fishes.

TABLE V. Fishes Collected from the KY 92 Improvement Project Impact Area.

Scientific Name	Common Name
Cal Creek, McCreary County	**9 July 1996**
Phoxinus erythrogaster	Southern Redbelly Dace
Semotilus atromaculatus	Creek Chub
Notropis rubellus	Rosyface Shiner
Hypentelium nigricans	Northern Hog Sucker
Micropterus salmoides	Largemouth Bass
Lepomis auritus	Redbreast Sunfish
Percina maculata	Blackside Darter
Etheostoma nigrum susanae	Johnny Darter
Etheostoma baileyi	Emerald Darter
Etheostoma sagitta	Arrow Darter
Etheostoma kennicotti	Stripetail Darter
Marsh Creek, McCreary County	**11 July 1996**
Semotilus atromaculatus	Creek Chub
Campostoma oligolepis	Largescale Stoneroller
Luxilus chrysocephalus	Striped Shiner

TABLE V (Continued)

Pimephales notatus	Bluntnose Minnow
Notropis rubellus	Rosyface Shiner
Hypentelium nigricans	Northern Hog Sucker
Ambloplites rupestris	Rock Bass
Micropterus punctulatus	Spotted Bass
Lepomis macrochirus	Bluegill
Lepomis cyanellus	Green Sunfish
Lepomis auritus x L. macrochirus	Hybrid
Lepomis megalotis	Longear Sunfish
Lepomis auritus	Redbreast Sunfish
Percina maculata	Blackside Darter
Etheostoma blennioides	Greenside Darter
Etheostoma baileyi	Emerald Darter
Etheostoma sagitta	Arrow Darter
Etheostoma kennicotti	Stripetail Darter
Osborn Creek, McCreary County	**9 July 1996**
Semotilus atromaculatus	Creek Chub
Luxilus chrysocephalus	Striped Shiner
Pimephales notatus	Bluntnose Minnow
Hypentelium nigricans	Northern Hog Sucker
Micropterus dolomieu	Smallmouth Bass
Micropterus punctulatus	Spotted Bass
Lepomis cyanellus	Green Sunfish
Lepomis megalotis	Longear Sunfish
Jellico Creek, Whitley County	**9 July 1996**
Nocomis micropogon	River Chub
Campostoma oligolepis	Largescale Stoneroller

Table V (Continued)

Luxilus chrysocephalus	Striped Shiner
Pimephales notatus	Bluntnose Minnow
Notropis rubellus	Rosyface Shiner
Hypentelium nigricans	Northern Hog Sucker
Ambloplites rupestris	Rock Bass
Micropterus punctulatus	Spotted Bass
Micropterus dolomieu	Smallmouth Bass
Lepomis cyanellus	Green Sunfish
Lepomis macrochirus	Bluegill
Lepomis megalotis	Longear Sunfish
Lepomis auritus	Redbreast Sunfish
Percina caprodes	Logperch
Etheostoma zonale	Banded Darter
Etheostoma baileyi	Emerald Darter
Etheostoma blennioides	Greenside Darter
Etheostoma caeruleum	Rainbow Darter
Etheostoma kennicotti	Stripetail Darter
Paint Creek, Whitley County	**18 March 1996**
Semotilus atromaculatus	Creek Chub
Campostoma oligolepis	Largescale Stoneroller
Luxilus chrysocephalus	Striped Shiner
Pimephales notatus	Bluntnose Minnow
Notropis rubellus	Rosyface Shiner
Lepomis macrochirus	Bluegill
Lepomis auritus	Redbreast Sunfish
Brier Creek, Whitley County	**12 March 1996**
Semotilis atromaculatus	Creek Chub
Luxilus chrysocephalus	Striped Shiner

TABLE V (Continued)

Etheostoma kennicotti	Stripetail Darter
Site 2, Brier Creek	**19 June 1996**
Semotilus atromaculatus	Creek Chub
Luxilus chrysocephalus	Striped Shiner
Lythrurus ardens	Rosefin Shiner
Cyprinella whipplei	Steelcolor Shiner
Pimephales notatus	Bluntnose Minnow
Micropterus dolomieu	Smallmouth Bass
Lepomis megalotis	Longear Sunfish
Etheostoma caeruleum	Rainbow Darter
Etheostoma spectabile	Orangethroat Darter

3. Aquatic Macroinvertebrates

A number of streams along the possible project alignments were sampled for macroinvertebrates, a group known for indicator species. They, individually and collectively, are often used as harbingers of ecological stress in aquatic systems. In particular, the orders Plecoptera, Ephemeroptera and Trichoptera can be especially sensitive to water pollution.

The macroinvertebrate sample from near the mouth of Cal Creek indicated reasonably good water quality. There was marginal evenness in the macroinvertebrate distribution within the sample, with the dominant species typically intolerant of decomposable organic wastes.

Cal Creek was sampled in the area of Wild Bill Stephens Road, and again at Kidd Cemetery Road because Alignment D will impact both of these areas. The sample from Wild Bill Stephens Rd. indicated degraded water quality at the sample site. However, the sample was taken post-emergence for many aquatic taxa and may be biased. The calculated diversity and equitability indices for the sample on Kidd Cemetery Road suggested the sample site had reasonably good water quality.

Marsh Creek macroinvertebrate sampling suggested that Marsh Creek is a stream under stress, and is probably impacted by external pollutants, including organic enrichment. Marsh Creek was very difficult to sample because of its deep sediments and few riffles.

Attempts to sample macroinvertebrates in Pleasant Run were unsuccessful. It appeared the stream has been heavily impacted by coal mining activities.

Roberts Branch will definitely be impacted by project construction. It is currently impacted by areal mining and reclamation, as well as cattle farming. This tributary joins Paint Creek to form a 20-foot waterfall. Paint Creek was sampled both above Roberts Branch and below the waterfall to determine if the tributary affected water quality. Samples taken above the falls suggested good water quality, with overall good balance across the macroinvertebrate taxa. The data suggested that Paint Creek was not significantly impacted by watershed pollutants. However, the sample taken below the falls suggested that Paint Creek has been significantly impacted by pollutants brought in from Roberts Branch.

Macroinvertebrate sampling from Jellico Creek indicated that the stream was not currently negatively impacted by organic enrichment. There was a reasonably good distribution of individuals across the taxa.

Only thirty-two individual aquatic insects were collected in the sediment samples of Perkins Creek in spite of the use of standard methods. That did not constitute an adequate sample for comparative purposes.

Samples taken from Brier Creek indicated water quality degradation. There was a lack of balance across the taxa; typical water quality indicator organisms suggested that the stream and the macroinvertebrate community had been impacted by induced stress. Brier Creek had obviously received organic influx from sewage lines of local homes, especially in the headwater area. TABLE VIII lists all aquatic insects, crayfish, and mussels collected from the impact area during the months of this study, along with diversity and equitability ratios, used to help judge the richness and variety present. The Shannon (1948) indices were used to determine diversity (range 0-10, with less than 3 indicating troubled streams) relative to population diversity. Margalef's (1975) equitability (range 0-1, with .4-.5 typical average reading) indicate distribution of individuals per species in the sample. These data should be interpreted with caution because of the lack of data over time and the small size of the samples.

TABLE VI. Aquatic Macroinvertebrates Collected during Field Investigations along the KY 92 Improvement Project Corridor.

1. Cal Creek at Kidd Cemetery Road, McCreary County, 31 May 1996

Ephemeroptera	
Heptageniidae	
Stenacron interpunctatum	83 nymphs
Stenonema terminatum	108 nymphs
Odonata	
Aeschnidae	
Boyeria vinosa	2 nymph
Plecoptera	
Nemouridae	
Amphinemura sp.	3 nymphs
Taeniopterygiidae	
Taeniopteryx sp.	1 nymph
Perlidae	
Eccoptura xanthenes	1 nymph
Megaloptera	
Corydalidae	
Nigronia serricornis	18 larvae
Tricoptera	
Hydropsychidae	
Hydropsyche sp.	31 larvae 3 pupae
Cheumatopsyche sp.	6 larvae
Odontoceridae	
Psilotreta sp.	193 larvae
Philopotamidae	
Chimarra sp.	4 larvae
Diptera	
Tipulidae	
Tipula abdominalis	24 larvae
Pilaria sp.	1 larva
Chironomidae	7 larvae
Decapoda	
Astacidae	
Orconectes sp.	2 juveniles
Cambarus sp.	13 juveniles

Total Taxa(s) = 7
Total Individuals(N) = 500
Equitability(e) = .53
Biological Diversity(d) = 2.63

TABLE VI (Continued)
2. Cal Creek Headwaters, Wild Bill Stephens Road, McCreary County, 12 June 1997

Ephemeroptera	
Heptageniidae	
Stenonema terminatum	27 nymphs
Stenacron interpunctatum	2 nymphs
Leptophlebiidae	
Paraleptophlebia sp.	1 nymph
Plecoptera	
Perlidae	
Perlinella sp.	2 nymphs
Chloroperlidae	
Alloperla sp.	16 nymphs
Megaloptera	
Sialidae	
Sialis sp.	1 larva
Trichoptera	
Hydropsychidae	
Ceratopsyche sp.	10 larvae 3 pupae
Hydropsyche sp.	2 larvae
Cheumatopsyche sp.	36 larvae
Philopotamidae	
Chimarra sp.	5 larvae
Odontoceridae	
Psilotreta sp.	1 larva
Coleoptera	
Elmidae	
Stenelmis sp.	1 larva
Eubriidae	
Ectopria sp.	2 larvae
Diptera	
Tipulidae	
Tipula abdominalis	1 larva
Pseudolimnophila sp.	2 larvae
Empididae	
Hemerodromia sp.	2 larvae 2 pupae
Simuliidae	
Simulium sp.	209 larvae 7 pupae
Chironomidae	116 larvae 3 pupae

TABLE VI (Continued)

Decapoda		
Cambaridae		
Cambarus sp.		2 juveniles
Orconectes sp.		1 juvenile
Isopoda		
Asellidae		
Lireus sp.		1 specimen
Oligochaeta		23 worms
Total Taxa(s)	= 490	
Total Individuals (N)	= 22	
Biological Diversity (d)	= 2.65	
Equitability (e)	= 0.41	

3. Perkins Creek, McCreary County, 11 October 1995

Ephemeroptera	
Heptageniidae	
Stenonema vicarium	2 nymphs
Stenonema terminatum	2 nymphs
Ephemerellidae	
Dannella simplex	1 nymph
Leptophlebiidae	
Paraleptophlebia sp.	6 nymphs
Baetidae	
Baetis sp.	3 nymphs
Odonata	
Aeschnidae	
Boyeria vinosa	1 nymph
Trichoptera	
Hydropsychidae	
Hydropsyche sp.	1 larva
Cheumatopsyche sp.	8 larvae
Philopotamidae	
Chimarra sp.	1 larva
Coleoptera	
Elmidae	
Stenelmis sp.	1 adult
Diptera	
Tipulidae	
Pilaria sp.	2 larvae
Simuliidae	
Simulium sp.	1 larva
Chironomidae	2 larvae
Isopoda	
Asellidae	
Lirceus sp.	1 specimen
Oligochaeta	1 worm

TABLE VI (Continued)

4. Marsh Creek near KY 592, McCreary County, 30 November 1995

Ephemeroptera		
Leptophlebiidae		
Leptophlebia sp.		12 nymphs
Habrophlebiodes sp.		8 nymphs
Plecoptera		
Capniidae		
Allocapnia sp.		23 nymphs
Nemouridae		
Nemoura sp.		1 larva
Megaloptera		
Sialidae		
Sialis sp.		1 larva
Diptera		
Tipulidae		
Hexatoma sp.		1 larva
Pilaria sp.		1 larva
Tipula sp.		1 larva
Chironomidae		1 larva
Amphipoda		
Crangonyctidae		
Crangonyx sp.		1 specimen
Oligochaeta		9 worms
Total Taxa(s)	= 11	
Total Individuals (N)	= 59	
Biological Diversity (d)	= 2.50	
Equitability (e)	= 0.73	

5. Marsh Creek at KY 92 bridge, McCreary County, 9 July 1996

Ephemeroptera	
Heptageniidae	
Stenonema vicarium	39 nymphs
Baetidae	
Baetis sp.	7 nymphs
Odonata	
Corduliidae	
Neurocordulia sp.	1 nymph
Plecoptera	
Unidentifiable specimen	1 nymph
Leuctridae	
Leuctra sp.	7 nymphs
Pertidae	

TABLE VI (Continued)

Acroneuria lycorias	26 nymphs
Megaloptera	
Corydalidae	
Nigronia serricornis	1 nymph
Trichoptera	
Hydropsychidae	
Cheumatopsyche sp.	1 larva
Diptera	
Tipulidae	
Hexatoma sp.	37 larvae
Simuliidae	
Simulium sp.	2 larvae
Chironomidae	11 larvae
Decapoda	
Cambaridae	
Orconectes sp.	5 juveniles

Total Taxa (s) = 294
Total Individuals (s) = 13
Biological diversity (d) = 2.31
Equitability (e) = 0.54

6. Osborn Creek, McCreary County, 12 June 1997

Ephemeroptera	
Heptageniidae	
Stenacron interpunctatum sp.	1 nymph
Oligoneuriidae	
Isonychia sp.	1 nymph
Caenidae	
Caenis sp.	1 nymph
Siphlonuridae	
Ameletus sp.	1 nymph
Baetidae	
Baetis sp.	3 nymphs
Plecoptera	
Perlidae	
Perlesta sp.	4 nymphs
Perlinella sp.	26 nymphs
Chloroperlidae	
Alloperla sp.	15 nymphs
Trichoptera	
Hydropsychidae	
Cheumatopsyche sp.	6 larvae
Philopotamidae	
Chimarra sp.	1 larva

TABLE VI (Continued)

Coleoptera		
Elmidae		
Stenelmis sp.		1 adult, 1 larva
Diptera		
Tipulidae		
Hexatoma sp.		14 larvae
Simuliidae		
Prosimulium sp.		3 larvae
Chironomidae		2 larvae
Amphipoda		
Asellidae		
Lirceus sp.		9 specimens
Oligochaeta		4 worms
Total Taxa	(s) = 17	
Total Individuals	(N) = 74	
Biological Diversity	(d) = 3.28	
Equitability	(e) = 0.28	

7. Jellico Creek, Whitley County, 19 June 1996

Ephemeroptera	
Oligoneuriidae	
Isonychia sp.	18 nymphs
Heptageniidae	
Stenonema vicarium	17 nymphs
Stenacron interpunctatum	1 nymph
Odonata	
Aeschnidae	
Boyeria vinosa	1 nymph
Plecoptera	
Perlidae	
Perlesta placida	9 nymphs
Acroneuria lycorias	17 nymphs
Megaloptera	
Corydalidae	
Corydalus cornutus	7 larvae
Trichoptera	
Philopotamidae	
Chimarra sp.	6 larvae
Hydropsychidae	
Cheumatopsyche sp.	1 larva
Diptera	
Tipulidae	
Tipula sp.	3 larvae
Athericidae	
Atherix sp.	2 larvae

TABLE VI (Continued)

Simuliidae	
Prosimulium sp.	2 larvae
Chironomidae	3 larvae
Isopoda	
Asellidae	
Lirceus sp.	1 specimen
Gastropoda	
Pleuroceridae	
Elimia sp.	48 specimens
Bivalvia	
Corbiculidae	
Corbicula fluminae	3 specimens
Oligochaeta	17 worms

Total Taxa (s) = 17
Total Individuals (n) = 215
Biological diversity (d)= 3.11
Equitability (e) = 0.71

8. Paint Creek above the falls, Whitley County, 10 October 1995

Ephemeroptera	
Heptageniidae	
Stenonema femoratum	1 nymph
Baetidae	
Baetis sp.	1 nymph
Odonata	
Calopterygidae	
Calopteryx sp.	3 nymphs
Gomphidae	
Stylogomphus albistylus	1 nymph
Dromogomphus spinosus	1 nymph
Cordulegastridae	
Cordulegaster sp.	1 nymph
Plecoptera	
Taeniopterygidae	
Taeniopteryx sp.	2 nymphs
Capniidae	
Allocapnia sp.	373 nymphs 6 adults
Hemiptera	
Veliidae	
Rhagovelia obesa	2 adults
Megaloptera	
Corydalidae	
Nigronia serricornis	10 larvae
Sialidae	

TABLE VI (Continued)

Sialis sp.	2 larvae
Coleoptera	
Psephenidae	
Psephenus herricki	1 larva
Elmidae	
Stenelmis sp.	4 larvae
Dubiraphia sp.	1 larva
Trichoptera	
Hydropsychidae	
Hydropsyche sp.	4 larvae
Cheumatopsyche sp.	12 larvae
Philopotamidae	
Chimarra sp.	24 larvae
Diptera	
Tipulidae	
Tipula sp.	2 larvae
Hexatoma sp.	5 larvae
Pilaria sp.	2 larvae
Chironomidae	14 larvae
Decapoda	
Cambaridae	
Cambarus sp.	2 juveniles
Isopoda	
Asellidae	
Lirceus sp.	2 specimens

Total Taxa (s) = 32
Total Individuals (N)= 222
Biological Diversity (d)= 3.94
Equitability (e)= 0.72

9. Paint Creek below the falls, Whitley County, 30 November 1995

Ephemeroptera	
Oligoneuriidae	
Isonychia sp.	1 nymph
Baetidae	
Baetis sp.	1 nymph
Plecoptera	
Taeniopterygidae	
Taeniopteryx sp.	2 nymphs
Capniidae	
Allocapnia sp.	373 nymphs 6 adults
Megaloptera	
Corydalidae	
Nigronia serricornis	7 larvae

TABLE VI (Continued)

Trichoptera	
Hydropsychidae	
Hydropsyche sp.	6 larvae
Cheumatopsyche sp.	4 larvae
Philopotamidae	
Chimarra sp.	2 larvae
Diptera	
Tipulidae	
Hexatoma sp.	2 larvae
Chironomidae	5 larvae
Isopoda	
Asellidae	
Lirceus sp.	172 specimens
Oligochaeta	2 worms

Total Taxa (s) = 13
Total Individuals (N) = 583
Biological Diversity (d) = 1.40
Equitability (e) = 0.23

10. Roberts Branch, Whitley County, 29 November 1995

Ephemeroptera	
Baetidae	
Baetis sp. # 1	2 nymphs
Baetis sp. # 2	1 nymph
Odonata	
Cordulegastridae	
Cordulegaster fasciata	4 nymphs
Plecoptera	
Perlodidae	
Isoperla orata	6 nymphs
Isoperla similis	3 nymphs
Capniidae	
Allocapnia sp.	15 nymphs
Megaloptera	
Corydalidae	
Nigronia fasciatus	1 larva
Nigronia serricornis	2 larvae
Trichoptera	
Hydropsychidae	
Cheumatopsyche sp.	1 larva
Philotomidae	
Chimarra sp.	1 larva
Diptera	
Tipulidae	
Tipula abdominalis	2 larvae
Hexatoma sp.	2 larvae

TABLE VI (Continued)

		Dicranota sp.	2 larvae
Isopoda			
	Asellidae		
		Lirceus sp.	427 specimens

Total Taxa (s) = 14
Total Individuals = 469
Biological Diversity = 0.71
Equitability (e) = 0.14

11. Pleasant Run upstream from KY 92 Crossing, McCreary County, 30 November 1995

Plecoptera			
	Capniidae		
		Allocapnia sp.	1 nymph
Megaloptera			
	Sialidae		
		Sialis sp.	1 larva
Diptera			
	Tipulidae		
		Pilaria sp.	1 larva

Nothing to Analyze

12. Staniford Hollow, Whitley County, 12 June 1997

Ephemeroptera			
	Heptageniidae		
		Stenacron interpunctatum	1 nymph
	Baetidae		
		Baetis sp.	2 nymphs
Plecoptera			
	Perlidae		
		Perlinella sp.	32 nymphs
	Nemouridae		
		Amphinemura sp.	3 nymphs
Hemiptera			
	Veliidae		
		Rhagovelia sp.	12 adults
Megaloptera			
	Corydalidae		
		Corydalus cornutus	1 larva
Trichoptera			
	Hydropsychidae		
		Ceratopsyche sp.	11 larvae
		Cheumatopsyche sp.	67 larvae
	Philopotamidae		
		Chimarra sp.	109 larvae
	Polycentropodidae		3 pupae

TABLE VI (Continued)

Rhyacophilidae	
Rhyacophila sp.	1 pupa
Coleoptera	
Elmidae	
Stenelmis sp.	4 adults
	3 larvae
Diptera	
Tipulidae	
Tipula abdominalis sp.	1 larva
Pseudolimnophila sp.	5 larvae
Dicranota sp.	4 larvae
Hexatoma sp.	9 larvae
Chironomidae	26 larvae
	4 pupae
Decapoda	
Cambaridae	
Cambarus sp.	1 adult
	1 juvenile
Amphipoda	
Crangonyctidae	
Crangonyx sp.	1 specimen

Total Taxa (s) = 20
Total Individuals (N) = 306
Biological Diversity (d) = 2.95
Equitability (e) = 0.55

13. Mt. Morgan Hollow, Whitley County, 21 April 1997

Ephemeroptera	
Ephemerellidae	
Ephemerella sp.	9 nymphs
Baetidae	
Baetis sp.	2 nymphs
Plecoptera	
Perlidae	
Isoperla clio	8 nymphs
Isoperla sp.	4 nymphs
Cultus sp.	2 nymphs
Chloroperlidae	
Alloperla sp.	9 nymphs
Nemouridae	
Ampinemura sp.	2 nymphs
Trichoptera	
Philopotomidae	
Wormaldia sp.	11 larvae
Hydropsychidae	

TABLE VI (Continued)

Ceratopsyche sp.	1 larva
Decapoda	
Cambaridae	
Orconectes sp.	1 juvenile

Total Taxa (s)	=	11
Total Individuals (N)	=	45
Biological Diversity (d)	=	3.03
Equitability (e)	=	1.0

14. Brier Creek, Whitley County, 9 October 1995

Ephemeroptera	
Baetidae	
Baetis spp.	8 nymphs
Odonata	
Gomphidae	
Stylogomphus albistylus	1 nymph
Hemiptera	
Veliidae	
Microvelia pulchella	1 nymph
Megaloptera	
Corydalidae	
Nigronia serricornis	9 larvae
Sialidae	
Sialis sp.	1 larva
Coleoptera	
Psephenidae	
Psephenus herricki	33 larvae
Eubriidae	
Ectopria nervosa	1 larva
Elmidae	
Stenelmis spp.	7 larvae
Trichoptera	
Hydropsychidae	
Hydropsyche spp.	14 larvae
Cheumatopsyche spp.	83 larvae
Philopotamidae	
Chimarra spp.	19 larvae
Diptera	
Tipulidae	
Hexatoma sp.	5 larvae
Pedicia sp.	2 larvae
Pilaria sp.	1 larva
Chironomidae	4 larvae
Decapoda	
Cambaridae	

TABLE VI (Continued)

Orconectes sp.			1 juvenile
Cambarus sp.			3 juveniles
Total Individuals (N)	=	193	
Total Taxa (s)	=	17	
Biological diversity (d)	=	2.78	
Equitability (e)	=	0.53	

4. Wetlands

The Clean Water Act (CWA) of 1977 gave the USACOE authority over "waters of the United States," including coastal and inland wetland areas. The USACOE, through Section 404 of the Act, regulates any activity in or near wetlands that may alter negatively the quality of the water associated with those wetlands (Redington, 1994).

Wetlands are among the most productive ecosystems in the world, their productivity being related to several factors. The periodic rise and fall of the water level brings nutrients in by flooding, and makes them more accessible when the water level retreats. Those water level fluctuations also keep the system well oxygenated. Wetlands serve important functions related to food chain production, storage areas for storm and flood waters, natural water filtration and purification, natural recharge areas, fish and wildlife habitat, and spawning and nesting sites for aquatic and terrestrial species.

There is potential for impacts to important wetland sites with the construction of this project. Forty-five wetland sites were identified along this project corridor, mostly along the Marsh Creek drainage and the Pleasant Run area. Many are very large wetland sites, and many are forested wetlands. (See Figures 2A-2I). These wetlands were delineated according to specifications in the Corps of Engineers Wetlands Delineation Manual. The Manual requires that hydrophytic vegetation, hydric soils, and wetland hydrology be investigated. Plants were identified; soils and hydrology were determined. Several of the delineated wetlands were indicated on the National Wetlands Inventory maps, and were used as a base to begin the investigations. A copy of the delineated wetlands map was sent to the Nashville District of the USACOE. The wetland habitat loss for each of the six proposed alternates is discussed in the Alternate Comparison section of this report. Not all delineated wetlands are included in the exhibits because they were not in the right-of-way for any of the corridors.

Direct impacts to wetlands will occur at Marsh Creek, at the base of Granny Holt Knob, Osborn Creek, the headwaters of Cal Creek, and Pleasant Run. In addition to the naturally occurring wetlands along the project corridor, there are a number of constructed ponds. These are not protected as wetlands, but should be replaced if the project impacts them, as they are important breeding areas for amphibians and good nesting sites for birds.

TABLE VI lists hectares of the various wetlands in the project area and indicates which wetland will be impacted by which alternate.

TABLE VII. Summary of Wetland Disturbance, in Hectares, Identified in the KY 92 Improvement Project Corridor

Wetland	Classification	A	B	C	D	E	F
		Alternate Disturbance					
A	PEM1C	.066		.002			
B	PEM1C	.043		.043			
C	PEM1C	.079	.071				
D	PEM1C	.128	.033				
E	PUBHh	.989					
F	PEM1C	2.570	.793				
G	PEM1C	3.392	.181				
H	PUBHh	.107					
I	RSS1A	1.051	.542				
J	PEM1C	3.997		1.387	1.387		
K	PSS1A	.113					
L	PSS1A	1.219					
M	PEM1C	.298					
N	PEM1C	.135		.054	.054		
O	PEM1C	4.035					
P	PEM1C	.149					
Q	PEM1C	.082					
R	PSS1A	3.400					
S	PFO1A	3.132		.365	.365		
T	PFO1A	.252					
U	PEM1C	.663					
W	PSS1A	9.456					
X	PSS1A	.131					
Y	PSS1A	4.203					
Z	PSSIA	19.000	2.170	1.830	1.830		
DD	PEM1C	.343	.045				
EE	PSS1A	.244	.244				
FF	PSS1A	10.60		.126	.126		
GG	PSS1A	15.550	1.756	.555	.555	.393	.393
II	PSS1A	2.829					
JJ	PSS1A	.258					
KK	PEM1C	.366				.014	.014
NN	PFO1Ah	1.574				.020	.020
OO	PSS1A	.127				.100	.100
PP	PSS1C	.258				.103	
QQ	PSS1C	1.458					
RR	PEM1C					.032	.032
SS	PEM1C					.542	.542

PEMIC=palustrine emergent deciduous vegetation, seasonally flooded
PSSIA= palustrine scrub-shrub, deciduous vegetation, temporarily flooded
PFOIA=palustrine forested, deciduous, temporarily flooded
PUBH=palustrine, unconsolidated bottom, permanently flooded
h=diked/impounded

C. Rare/Endangered Species

The USFWS has documented three federally-listed species known to occur in the project area: the red-cockaded woodpecker (*Picoides borealis*), the blackside dace (*Phoxinus cumberlandensis*) and the Cumberland elktoe (*Alasmidonta atropurpurea*). The red-cockaded woodpecker, a bird requiring mature pine forests with open understory, is found very locally in southeastern Kentucky, the northernmost extent of its range. It is listed as "Endangered" with the USFWS and the KSNPC. The Red-cockaded woodpecker has been identified in the Pleasant Run drainage area; however, at this time, there are no known colonies there. The rare Cumberland blackside dace, listed as "Threatened" by the USFWS and "Endangered" by KSNPC, is found only in the Southeast area of the upper Cumberland River drainage. It inhabits rocky pools of headwaters and creeks that are well-shaded by dense riparian vegetation and with cool water much of the year. There are records from the Marsh and Jellico Creek basins. A USFS record indicated the occurrence of the dace at the mouth of Brier Creek near Williamsburg. Brier Creek will experience extensive permanent changes with the construction of the project. The Cumberland elktoe has been identified in Marsh Creek from several sites on the Hollyhill quadrangle. This mussel is found in medium-sized, low to moderate gradient, high quality streams. It will likely be in areas of near zero flow, occupying interstitial spaces within cobble and/or boulder substrate. These species were not identified in the impact area, but there is possible evidence of the red-cockaded woodpecker near the corridor. Figures 16 and 17 indicate potential habitat and evidence of the woodpecker.

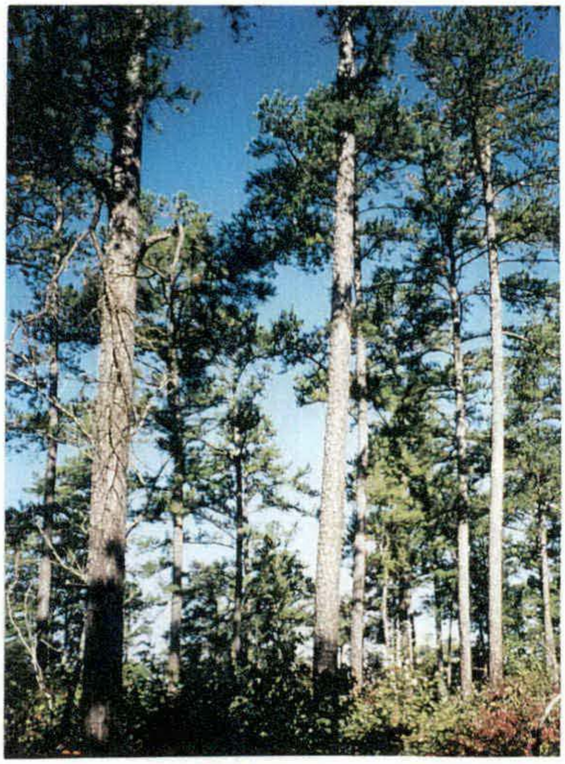


Figure 16. Potential Red-cockaded Woodpecker Habitat

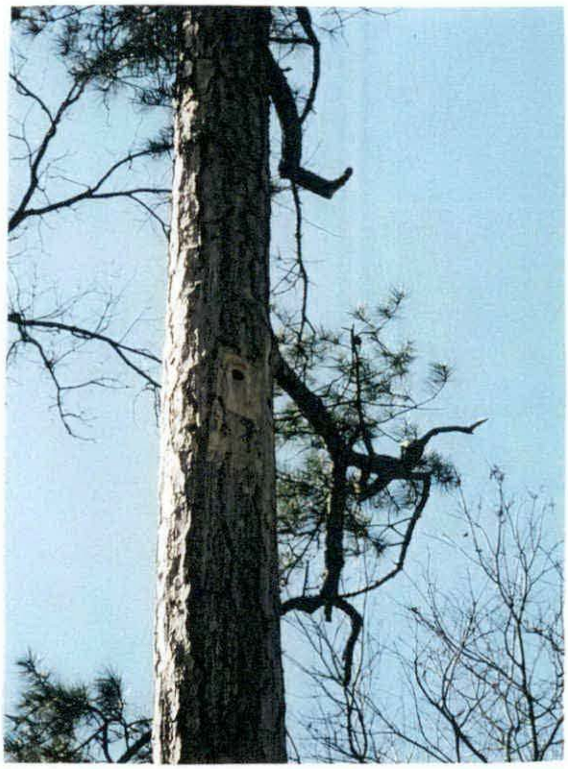


Figure 17. Artificial Nest Cavity

The KSNPC, KDFWR and the USFS also list a number of rare species being considered for future listing with the potential to occur in the vicinity of the proposed project. *Etheostoma sagitta,* the arrow darter and *E. nigrum susanae,* the Cumberland johnny darter, two species from these lists, were identified. There is also potential to impact the KSNPC-listed endangered mussel *Anadontiodes denigratis* (Laudermilk, 1997, personal communication). This species is known from Clear Creek, which enters Marsh Creek approximately one mile north of the project area. It is an extremely rare mussel, being endemic to the upper Cumberland River drainage. In addition to the above-mentioned species, evidence (tracks and deer remains) of the state and federally "endangered" cougar were found in Staniford Hollow in the project impact area. TABLE VII lists those rare "agency" species with high probability of occurrence in the impact area, and other rare species identified in project corridor, although not previously documented there.

TABLE VIII. Summary of Potential Rare, Threatened, and Endangered Species in KY 92 Reconstruction Area.

Scientific Name	Common Name	Federal Ranking	State Ranking	Agency Documentation
Aster concolor	Eastern Silvery Aster		T	KSNPC, USFS
**Baptista tinctoria*	Yellow Wild Indigo		T	Identified
Bartonia virginica	Yellow Screwstem		E	KSNPC
Calamagrostis cinnoides	Cinna-like Reed Grass		S	USFS
Calycanthus floridus, var. *glaucus*	Sweet Shrub		T	KSNPC, USFS
**Carex aestivalis*	Summer Sedge	E	E	Identified
**Carex joori*	Cypress Sedge	E		Identified
**Carex leptonervia*	Finely-nerved Sedge	E	E	Identified
Carex gigantea	Large Sedge		T	KSNPC
Cladrastis kentukea	Yellow-wood		S	USFS
Cleistes divaricata	Spreading Pogonia		S	USFS
Clematis glaucophylla	Clematis		E	USFS
Coreopsis pubescens, var. *pubescens*	Star Tickseed		S	KSNPC
Cypripedium kentuckiense	Kentucky Lady Slipper		S	KSNPC, USFWS
Gratiola pilosa	Shaggy Hedge Hyssop		E	KSNPC
Helianthus atrorubens	Sunflower		S	USFS

TABLE VIII (Continued)

Hexastylis contracta	Southern Heartleaf		E	KSNPC, USFWS
Lilium philadelphicum var. *philadelphicum*	Wood Lily		T	KSNPC
Lobelia nuttallii	Nuttall's Lobelia		E	KSNPC
Maianthemum canadense	Wild Lily-of-the-Valley		T	KSNPC
Malus angustifolia	Southern Crabapple		S	KSNPC
Orontium aquaticum	Golden Club		T	KSNPC
Parnassia asarifolia	Kidneyleaf Grass of Parnassus		E	KSNPC, USFS
Platanthera cristata	Yellow-crested Orchid		E	KSNPC
Platanthera integrilabia	White Fringeless Orchid		T	KSNPC, USFWS
Polygala polygama, var. *polygama*	Racemed Milkwort		E	KSNPC
Rhynchospora globularis, var. *globularis*	Globe Beaked-rush		S	KSNPC
**Solidago curtisii*	Curtis' Goldenrod		T	Identified
Talinum teretifolium	Roundleaf Fameflower		T	KSNPC
Vallisneria americana	Eel-grass		S	KSNPC, USFS
Vernonia noveboracensis	New York Ironweed		E	KSNPC

TABLE VIII (Continued)

Alasmidonta atropurpurea	Cumberland Elktoe	PE	E	USFWS, USFS
Anodontoides denigratus	Cumberland Papershell		E	USFWS
Etheostoma nigrum susanae	Cumberland Johnny Darter		E	KSNPC, USFWS KDFWR, USFS
Etheostoma sagitta	Arrow Darter		S	KDFWR
Phoxinus cumberlandensis	Mountain Blackside Dace	LT	E	USFWS, KSNPC USFS
Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard		T	KSNPC, KDFWR USFS
Pituophis m. melanoleucus	N. Pine Snake		T	KDFWR
Accipiter striatus	Sharp-shinned Hawk		S	KSNPC, KDFWR
Picoides borealis	Red-cockaded Woodpecker	LE	E	USFWS, KSNPC USFS
Corynorhinus rafinesquii	Rafinesque's Big-eared Bat		T	KDFWR
Felis concolor	Mountain Lion	E	E	KDFWR, USFS
Myotis leibii	Small-footed Bat		E	USFS
Myotis septentrionalis	Northern Long-eared Bat		S	USFS
Myotis sodalis	Indiana Bat	LE	E	USFS
Neotoma magister	Alleghany Woodrat	C2		USFWS, USFS
Ursus americanus	Black Bear		S	USFS

C2=Federal Candidate; E=Endangered; S=Special Concern (KSNPC); T=Threatened; PE=Proposed Endangered; PT=Proposed Threatened; Sensitive (USFS); *Not previously documented but found in study area during field studies

D. Project Impacts

1. Aquatic Impacts

The proposed reconstruction of KY 92 will have short-term impacts on water quality in area streams. The majority of construction impacts, such as sedimentation and turbidity, will occur mostly during the construction phase and will be temporary. Those streams impacted (depending upon the alignment choice) include Perkins Creek, Cal Creek, Marsh Creek, Pleasant Run, Jellico Creek, Paint Creek, Brier Creek, and tributaries of these streams. Some aquatic habitat will be permanently altered or lost through this construction. Brier Creek, in any scenario, will be permanently changed.

Channel changes and other associated stream disruptions can have adverse impacts to those streams altered. Increased suspended and dissolved solids may result in increased temperatures and decreased dissolved oxygen. These increases in solids will have a direct impact on fish, and the increased turbidity and suspended sediment loads will affect benthic organisms. That, in turn, will also affect stream fish.

Channelization involves the clearing of one or both stream banks, creating impacts on both terrestrial and aquatic ecosystems. Adverse effects can be substantial. The disturbance of streambed substrates and stream banks can create a temporary turbidity problem. Unless measures are employed to prevent it, a continued erosion problem can lead to a permanent increase in turbidity. Turbidity decreases the amount of light penetrating the water, limiting the photosynthesis of benthic algae, phytoplankton, and macrophytes. Turbidity also results in an increase in downstream sedimentation. As the sediments settle out, they can clog the gills of benthic invertebrates, smother fish eggs and create unsuitable substrates for aquatic life.

Channelization, through substrate disruption, can destroy habitat for benthic algae, rooted macrophytes, and burrowing macroinvertebrates. The fauna and flora often associated with stream obstructions, such as accumulated sediments, logjams, and boulders, represent the base of the aquatic food chain. Destruction of these populations can have a profound effect on the overall ecosystem productivity.

Channelization can drastically alter stream flow. That, coupled with the loss of habitat diversity, can cause adverse effects on aquatic organisms. Channelization disrupts valuable feeding, spawning and nursery areas by changing suitable substrate and flow regimes. Channelization alters the natural run-riffle-pool sequence, creating a more uniform channel. Certain invertebrate species, such as chironomids and oligochaetes, inhabit deep pools, while others, such as caddisflies, mayflies, and stoneflies, are adapted to shallow riffle areas. The degree of impact depends on the extent of channelization activities, location, and whether or not mitigation measures are employed.

Another water quality problem that can result from substrate disturbance is the disturbance and re-suspension of toxic materials. Toxins introduced into the system by mine drainage or other runoff sources may become buried in the sediments over time. Sediment re-suspension allows the potential uptake of these toxins by aquatic organisms. Some of the potentially impacted streams have probably already been affected by mine drainage.

Water quality problems may occur when the overhanging stream canopy is removed. This action automatically raises stream temperature, and removes valuable streamside habitat areas (root masses, stream-side obstructions). Temperatures could rise above the optimum levels for some aquatic species, resulting in their death (Simpson et al., 1982; Karr and Schlosser, 1977). Increased stream temperature can lower dissolved oxygen levels, adversely affecting fish downstream of rechanneled areas. Riparian vegetation plays a number of roles in the terrestrial ecosystem. It serves as a buffer for water runoff during heavy rains, preventing erosion by holding the soil in place. The vegetation also provides cover, food and nesting habitat for a variety of herpetofauna, birds, and mammals. Changes in riparian vegetation lead to changes in species diversity, and thus, decreased productivity.

Another problem associated with channelization is the change in water levels in adjacent terrestrial ecosystems. A drying effect sometimes occurs following channelization, with the vegetative community changing from hydric to mesic species. This effect indirectly affects the productivity of the terrestrial ecosystem, because numerous species of reptiles, amphibians, birds, and mammals feed on aquatic plants and animals. The competition thus created among these species ultimately affects the entire ecosystem.

The 100-year flood boundary may be encroached with the project's construction. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment so that any 100-year flood can be tolerated without substantial increases in flood heights. Floodplain encroachment reduces the flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. Floodplain encroachment requires close coordination with the USACOE and Kentucky's DOW. Permits that may be required when encroaching a floodplain are discussed in the Introduction.

Areas with wetlands will be impacted with the construction of this project, especially in the Marsh Creek and Pleasant Run areas. Alternate A will take 4.757 hectares(hc) or 11.78 acres(ac) of wetlands; Alternate C, 4.362hc (10.80ac); Alternate D, 4.317hc (10.69ac); Alternate E, 1.205hc (2.98ac); Alternate F, 1.102hc (2.73ac); and Alternate G, 1.173hc (2.905ac). See Figures 2A-2I for individual wetlands impacted by each alternate. It is important to realize that the hydrologic cycle is tied directly to wetlands that act as surface storage areas. The standing water may come from annual spring flooding and/or storm water run-off. The surface water percolates down through the soil to the ground water aquifer that supplies water for human consumption. Therefore, wetlands benefit humans by acting as buffers for flood control, by providing plant and animal habitats, and by protecting our drinking water by pollutant filtration.

Wetland functions have value on several levels, including internal, local, regional, and global. Functions providing internal values are those that maintain the wetland and are essential to the continued existence of the wetland. Also, many functions have external values beyond the wetland itself. Wetlands affect adjacent or nearby ecosystems by reducing flooding downstream and/or removing nutrients from wastewater. Wetlands also have significant effects on air quality through altering the nitrogen, sulfur, methane, and carbon cycles.

2. Terrestrial Impacts

Construction of the new roadway will initially eliminate all flora and fauna in the project path. The alteration of terrestrial vegetation and wildlife habitat will inevitably affect wildlife. The disrupted areas will provide alternative habitat with less diversity. Placement of spoil material will bury habitat and displace wildlife. There will be impacts on soils and erosion associated with the construction, resulting in decreased productivity. In time, revegetation will stabilize the construction sites and impacts will diminish.

Most of the area is forested. Forested areas, especially mature forests, are locally important due to the diverse floral and faunal communities they harbor. The long replacement time (80-150 years) for mature forest habitat makes impacted woodlands a significant habitat loss. Right-of-way slopes will be maintained as mowed grassland, but because these slopes represent habitat reduction, fewer animal species will be found in the area. Woodland flora and fauna will be replaced by species more tolerant to grasslands. Animal travel corridors will likely be interrupted with the construction of this roadway. Deer trails were found throughout the corridor area, black bear has been seen in the corridor area, and bobcats are known to inhabit the rugged clifflines in the corridor. Until the area wildlife adapts to the new roadway, there will likely be more road kills than usual. Wildlife habitat will be fragmented; migratory birds, especially sensitive to habitat fragmentation, will be more vulnerable to predation because their nesting areas may be disrupted.

There are several commercial coal seams, and strip mining has taken place in the project corridor. The project will impact reclaimed strip mined areas. Earth settlement problems may occur in these areas. Abandoned underground mines also occur in the area and pose the potential for subsidence-related problems. There are also several active gas wells in the project corridor. Exhibits 2A, 2B, and 2C indicate gas lines along the proposed project route.

E. Alternate Route Comparison

Six alternate alignments are being considered to improve KY 92 from Pine Knot to Williamsburg. However, the narrow roadway and substandard geometrics will remain a problem for drivers. Three of the alternates, A, C and D, begin at Pine Knot and go to the McCreary/Whitley County line near the Pleasant Run bridge. There, alternates E, F, and G begin, and move east to I-75 at Williamsburg (See Figures 2A-2I).

All proposed alternates will require taking large amounts of various habitats. In McCreary County, Alternate A will require the taking of 124.8hc (309.13ac) of viable habitats, Alternate C, 102.0hc (252.65 ac); and Alternate D, 102.6hc (254.14 ac). In Whitley County, Alternate E will take 118.8hc (294.27ac) of habitats, Alternate F will take 124.8hc (309.13ac); and Alternate G will take 131.5hc (325.73 ac).

With the McCreary County section of the proposed project, Alternate A will impact 4.757hc (11.78ac) of wetlands, Alternate C will impact 4.362hc (10.81ac) of wetlands, while Alternate D will impact 4.317hc.(10.69ac) In Whitley County, Alternate E will require taking 1.205hc (2.98ac) of wetlands, Alternate F, 1.102hc (2.73ac), and Alternate G, 1.173hc (2.91ac).

All alternates will require some degree of stream disturbance. Exhibits 2A, 2B, and 2C indicate the disturbances for each alternate. Alternate A will require 1,670m (5479ft) of stream disturbance; Alternate C, 1,695m (5561ft); Alternate D, 1,700m (5578ft); Alternate E, 4,705m (15,437ft); Alternate F, 3,505m (11,500ft); and Alternate G, 2,575m (8,449).

Some farm ponds will be impacted with the construction of this project. Ponds are not considered wetlands or protected under the Clean Water Act. However, they can be important breeding sites for amphibians in particular, and provide habitat for birds and reptiles. Some of the ponds in the project vicinity harbor known rare species, and it is likely that others may do the same. Those ponds taken with the construction of this project should be replaced. Alternate A will not impact ponds; Alternate C will take 3 ponds; Alternate D, 2 ponds; Alternates E and F, 4 ponds; and Alternate G, 5 ponds.

F. Mitigation Measures

The "Memorandum of Agreement (MOA) between the Environmental Protection Agency and the Department of the Army concerning the Determination of Mitigation Under the Clean Water Act, Section 404 (b) (1) Guidelines"(1989) expresses the explicit intent of the Army and USEPA to implement the objective of the Clean Water Act to restore and maintain the chemical, physical, and biological integrity of the nation's wetlands, and to strive to achieve a goal of no overall net loss of values and functions. Potential adverse environmental impacts to the palustrine emergent vegetation wetlands, the forested wetland areas, and the scrub-shrub wetlands must be avoided to the maximum extent practicable. Section 230.10 of the Guidelines requires that "no discharge will be permitted if there is a feasible alternative to the proposed discharge, having less adverse impacts to the wetlands, provided the alternative does not have other major environmental impacts."

When adverse impacts to wetlands are unavoidable, appropriate compensatory mitigation of the impacted wetland is required. When determining compensatory mitigation, the functional values of the impacted resource must be considered. In order to understand the impacted wetland and be able to attempt to recreate it, some important questions to be asked are:

1. What are its functions?
2. Which functions must be replaced?
3. Can the plant and animal life be reproduced in the created wetland?
4. What will be the cost of maintaining these wetlands?
5. Will valuable upland habitat be destroyed in creating a new wetland site?

Wetland mitigation and replacement typically requires replacement on at least a 2:1 ratio. When possible, wetland replacement should be on-site and in-kind with restoration of existing degraded wetlands being preferred to the creation of wetlands. If on-site compensatory mitigation is not practicable, another site should be chosen in close proximity and in the same watershed, if possible. Restoration shows a much greater margin of success than wetland creation. In order to ensure that thorough restoration takes place, the restored wetland must be monitored for a number of years.

Wetlands are considered highly valuable ecosystems, providing unique habitat for diverse floral and faunal communities. A water quality certification through KDOW is required when there is a discharge into any wetland or when any action causes or results in a loss of 1/3ac or more of wetlands. The wetland habitat loss for each proposed alternate was discussed previously in the Alternate Comparison section.

Where alternate alignments cannot be located so as to avoid wetland impacts, every effort must be made to minimize the impacts. The use of retaining walls, steepening of slopes and the taking of minimum right-of-way outside construction limits should be investigated to minimize impacts. Special precautions should be taken so that excessive sediments from construction activities do not enter the wetlands. Heavy equipment should not be allowed to traverse or be parked on the wetland areas. Post-construction techniques to minimize impacts include not maintaining the right-of-way by mowing or spraying herbicides.

Wetlands have taken thousands of years to evolve a multitude of functions and interactions, of which only a few are known and understood. It is very unlikely that destroyed wetlands can be fully re-created with all functions intact. It has been estimated that less than half of all those wetlands destroyed have been even partially successfully replicated (Redington, 1994).

Many construction impacts will occur mostly during the construction phase of this project and should be temporary in nature. However, some aquatic and terrestrial habitat will be permanently lost or altered by construction activities, in particular the whole Brier Creek drainage area and the headwaters of Cal Creek.

Artificial changes to a natural stream environment may have far-reaching negative impacts and long-term degradation with altered hydrologic flows. Short-term impacts from rechanneling, and/or culverts will include the direct disturbance of benthic and riparian habitat, along with an increase in downstream turbidity, dissolved solids, suspended solids, conductivity, and nutrients. All project area streams will likely be impacted by sedimentation during road construction. It appears that the headwaters of Cal Creek will be changed by culvert placement. There are wetland areas in the headwaters of Cal Creek, a stream considered significant by The Nature Conservancy. Necessary stream crossings should be made perpendicular to the direction of flow, and culverts should be wide enough to pass high flows and should not restrict aquatic vertebrate movement within the stream.

Channel excavations should be restricted to the absolute minimum necessary. If at all possible, rechanneling of area tributaries should be avoided. If no other alternatives exist, stream disturbance should be minimized and mitigated pursuant to the Clean Water Act. Techniques that minimize adverse impacts to the aquatic system and speed recovery of the values of the affected stream sections should be employed. Channel changes should be excavated and stabilized, when necessary, before diverting water through the new channel. The contractor must be told of any limitations in the work area or special conditions imposed by USACOE 404 and/or DOW 401 water quality certifications. Instream work with equipment should be kept to the absolute minimum so as to protect the fish, wildlife and water quality of the stream. If frequent stream crossings are expected, temporary crossings should be constructed. Excavation from construction should never be deposited in or near the stream.

Particular attention should be given to the size, shape and stability of the natural stream channel in sizing channel relocations. Channel changes should be excavated and lined with riprap when necessary before diverting water through the new channel. Stream alignment variations should be gradual so as not to increase scour potential of the channel. Proposed stream rechanneling should minimize net loss of stream length by replacing meanders. Stream re-channelization should include the construction of riffles and pools that simulate natural conditions. The same pool/riffle sequences should be maintained. The overhanging tree canopy should be left undisturbed to the greatest extent possible. Habitat improvement structures should be placed in the relocated channel. Re-vegetating with native floral species should provide habitat for existing species and attract lower food chain organisms that will then draw indigenous fishes and invertebrates. Stream rechannelings involving discharges into two hundred linear feet or more of any stream or stream bank, shown as intermittent or represented as a solid blue line on a USGS 7.5 minute topographic map, requires close coordination with Kentucky's DOW for 401 Water Quality Certification. Also, an Individual Section 404 Dredge and Fill Permit may be required from the USACOE prior to any construction work on the proposed project. Permittees must meet all conditions, restrictions, and notification procedures required by the Nationwide Permit prior to any work under said permit.

It is recommended that bridge abutments should be kept out of the water, and any necessary box culverts should not impede low flow of water in the impacted streams. Where possible, diversion channels should be constructed to keep surface flow away from the construction site or to direct flow from the construction site into appropriate sediment control devices. Seeding with temporary vegetation to help control sediment runoff should be considered. Construction should take place in late summer or fall during the low flow period. All these measures will help in avoiding adverse impacts to the Cumberland elktoe, known to inhabit Marsh Creek downstream of the project area. These measures will also help mitigate impacts to the Cumberland blackside dace, the Cumberland johnny darter, and the arrow darter, any area mussels, and will help to protect water quality in area streams.

Chapter IV

Summary and Conclusion

The proposed highway project involves the reconstruction of KY 92 from Pine Knot in McCreary County to Williamsburg in Whitley County, a distance of 32.2km (20.1mi). Six alternate alignments, each requiring bridge construction, are being considered. Alternates A, C, and D will require bridges over Marsh Creek and Osborn Creek, as well as Pleasant Run. Alternates E, F, and G will require bridges over Jellico Creek. Because of the project length and the variety of habitats through which it passes, there is high potential for adverse impacts to the ecosystem. The mountainous terrain leads to extensive stream involvement.

A large number of wetland sites have been identified and delineated in this project corridor, in particular the Marsh Creek drainage area. The Pleasant Run floodplain area in Whitley County also involves some large wetlands. Wetlands are important natural resources, and their destruction may adversely affect ground water quality. Likewise, the organisms that depend on the wetlands for shelter, breeding and feeding will be adversely affected. The Nashville District of the USACOE is the coordinating agency involved in the permitting process for this project.

The study not only delineated wetlands, but also described stream chemistry, macroinvertebrates and fish species. The flora of the project corridors was sampled, and rare, threatened and endangered species were researched. These studies were conducted so data could be made available to, and used by, the appropriate agencies.

There is a high potential for adverse impacts because of the number of rare species documented from the general project vicinity. Three of these are federally protected: the Cumberland blackside dace, known from Ryans Creek and the mouth of Brier Creek; the red-cockaded woodpecker, documented from the Pleasant Run area, where suitable habitat for this species exists along the project route; and the cumberland elktoe, known from Marsh Creek, downstream of the project crossings. Impacts to this species may occur through siltation during the construction phase of the project. In addition to the species mentioned, the federally endangered mountain lion has been reported in the area, and mountain lion tracks were seen in Staniford Hollow. The habitat of the allegheny woodrat (Federal C2), common on rock outcrops throughout the project corridor, will be impacted by the project's construction.

Other state listed and unusual species also occur in the area. A number of rare plants and animals have the potential to occur in the project route. The Cumberland johnny darter was found in Cal Creek, and The arrow darter occurred in Marsh and Cal Creeks. Excessive sediments during construction will likely impact these fishes.

Project construction will put in motion Section 7 of the Endangered Species Act, which calls for a biological assessment of the affected species if critical habitat of any threatened or endangered species will be destroyed or altered. If it is determined that the proposed construction does adversely affect critical habitat, formal consultation between the USFWS and the Kentucky Transportation Cabinet and Federal Highway Administration will be initiated.

Extensive stream involvement will be necessary in the Brier Creek drainage area, with rechanneling occurring essentially throughout the length of the stream. Other waterways that will be changed are the headwaters of Cal Creek, Pleasant Run and its associated tributaries, and the Paint Creek drainage area, including portions of Roberts Branch. In McCreary County, Alternate A will require 1,670m (5479ft) of stream disturbance; Alternate C, 1,695m (5561ft); and Alternate D, 1,700m (5578ft). From the Whitley County line to the project's terminus at Williamsburg, Alternate E will require 4,705m (15,437ft) of stream disturbance; Alternate F, 3,505m (11,500ft); and Alternate G, 2,575m (8,449ft).

Floodplains will likely be encroached in the areas of Marsh Creek, Pleasant Run, Jellico Creek, and Brier Creek. Floodplain encroachment requires close coordination with Kentucky's DOW and the USACOE through the Clean Water Act.

Because forested areas will be dissected with this project's construction, there will be habitat fragmentation and the disruption of wildlife travel corridors is likely. Migratory bird species will be especially affected. Fragmentation of habitat may disrupt nesting areas, thus making the birds more prone to predation. There may be a short-term increase in road-kills, including large mammals such as deer, bear and cougar, until area animals become accustomed to the new roadway.

There are no "right-wrong" alternatives because each segment of each alternate is a potential "final choice." In many cases, there is very little difference in land and water degradation (See TABLE VIII). In practicality, highway engineering is determined to a degree by local economics and politics. However, this study will help in segment choices and in the mitigation of potential damage as planning progresses, and will definitely aid in the purposeful avoidance of those areas with populations of rare, threatened or endangered species. Attention to these "listed" species when alternative routes are available can also save hundreds of thousands of dollars in mitigation measures.

Table IX. Summary of Impacts Associated with Six Alternates for Reconstruction of KY 92 in McCreary and Whitley Counties, Kentucky.

Impacts	Alternate A	Alternate C	Alternate D	Alternate E	Alternate F	Alternate G
Wetlands	4.75hc 11.77ac	4.36hc 10.80ac	4.32hc 10.70ac	1.21hc 3.0ac	1.10hc 2.7ac	1.17hc 2.9ac
Stream disturbance	1,670m 5779ft	1,695m 5561ft	1,700m 5578ft	4,705m 15437ft	3,505m 11500ft	2,575m 8449ft
Rare Species	yes	yes	yes	yes	yes	yes
Ponds	no	3	2	4	4	5
Floodplain	yes	yes	no	yes	yes	yes
Viable Habitats	124.8hc 309.13ac	102.0hc 252.65ac	102.6hc 254.15ac	118.8hc 294.27	124.8hc 309.13ac	131.5hc 325.73ac

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